UNIVERSITY OF CALIFORNIA—COLLEGE OF AGRICULTURE

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FEEDING OF FARM ANIMALS

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AGRICULTURAL EXPERIMENT STATION

FEEDING OF FARM ANIMALS.

PRINCIPLES OF ANIMAL NUTRITION: COMPOSITION AND DIGESTIBILITY OF FOODS: COMMENTS ON VARIOUS FODDERS AND FEEDSTUFFS, INCLUDING SUGAR-BEET PULP: TABLES FOR COMPOUNDING RATIONS: SUGGESTIVE RATIONS FOR DIFFERENT FARM ANIMALS: USE OF FRUITS FOR STOCK.

The great interest which is being taken in the feeding of animals and the constant demands which are being made on this Station for information along these lines, has made it imperative for us to issue this Bulletin, setting forth the general principles underlying all animal feeding, together with such data and comments as have seemed most essential for the farmer and stockman. Notwithstanding that the majority of the experiment stations have issued bulletins covering the same subject, the climatic conditions obtaining in California and the wide difference in our foods from those of the older States render it necessary that this Bulletin be issued to deal more intelligently with the environments peculiar to this State.

Some of the matter here presented concerning the general principles of feeding is reprinted from the Annual Report for 1894–95, the edition of which is exhausted. So far as possible all analyses given are from our own laboratories, and represent foods grown in California. We have not been able, however, to analyze all the foods used in the State, and therefore have copied many analyses from Professor Henry's "Feeds and Feeding," in order to present the data in a more complete form.

OBJECTS OF FEEDING.

It is well known that the young animal body requires food to supply the material necessary for its growth. But beyond this, and continuing during and past the growing stage, there is a constant wearing out and breaking down of all the tissues of the body, and this loss must be supplied in order to keep the animal in a normal, healthy condition. Not only must the worn-out tissues be replaced, but the material used in producing the energy necessary for carrying on all voluntary and involuntary functions, must also be supplied. An animal which is working hard in the plow is using up a great deal of fatty tissue as well as muscle; but the animal which is doing nothing, that is, making no voluntary exertion, experiences a loss of tissue through the constant production of heat necessary for the maintenance of the normal body-temperature, and also for the performance of all the involuntary functions of the body. Hence, we might summarize the objects of feeding as follows:

(a) To maintain bodily heat.
(b) To repair waste of tissue.
(c) To reproduce young.
(d) To form new tissues or organs.
(e) To perform muscular labor.
(f) To secrete various products.
(g) To lay up reserve stores.

COMPOSITION OF FOODS.

In order to see how these objects may be best carried out, we must understand the composition of these tissues that need rebuilding, and also the composition of the various foodstuffs at our command. Viewing them side by side, for the purpose of better comparison, a general analysis shows each to consist of the same four main ingredients —water, mineral matters, nitrogenous and non-nitrogenous material.

Water constitutes about two-thirds of the weight of the body, entering into the composition of all its tissues and fluids. As it does not form nearly so large a proportion of the ordinary ration fed to stock, we can readily understand the necessity of its forming a separate part of the animal's food.

The *mineral matters* comprise about five per cent. of the body-weight, and have important functions to perform, such as entering into the formation of the teeth and bones, and regulating the density of the blood and other fluids of the body, such as the juice of the stomach, etc. When estimating food values the mineral or inorganic ingredients are generally omitted, not on account of any lack of importance of that portion of the food, but for the reason that nearly all feedstuffs, no matter of what description, contain a sufficient amount of these substances, which are mainly lime, potash, and phosphoric acid, with varying amounts of sodium, iron, magnesia, sulphuric and hydrochloric acids, silica, etc.

The *nitrogenous matters* of the body, of which the major part are called proteids, the only ones that contain nitrogen, are found mostly in the muscle, gelatinous part of the bones and tendons, brain, nerves, and internal organs; in short, all the working machinery of the body is composed principally of this important material. Similarly, in the foods, the main part of all the nitrogenous material is termed protein, signifying, by its Greek derivation, to take first place. Another name for the proteids is albuminoids. This important ingredient of the food is found largely in the white-of-egg, the "myosin" of lean meat, gluten of grains, oil-cake meals, etc. Besides the albuminoids there are other nitrogenous matters, chief among which is the class known as amides, which are found to a greater or less extent in all foods, more particularly in those of vegetable origin. The physiological action of amides is similar to that of fat and carbohydrates.

The albuminoids in the different food-materials are estimated from the nitrogen by multiplying the figure for the latter by 6.25; nitrogen being sixteen per cent. of the albuminoids. In England the factor used is 6.33.

The nitrogenous compounds of the food are generally, for the above reasons, reported as *crude protein*.

The necessity of the albuminoids, or protein, in the daily food of an animal depends not only upon its important relation to such tissues as bone, muscle, blood, nerves, tendons, etc., but also upon the fact

that, as far as we know, no albuminoids or protein matter is formed in the body except by the transformation of similar substances presented to it from external sources. It cannot be obtained by conversion of any other material.

The protein can be changed into fats, and thus may serve as a fuel for the body, but *fats* cannot replace *protein*. Because the protein, or flesh-forming ingredients, *can* serve as fuel, and in certain cases take the place of fats and carbohydrates, it would be extremely unwise and uneconomical to use them for that purpose, as it would always be done at a far greater cost.

The *non-nitrogenous* part of the body is principally fat, the substance which is consumed in the production of heat and energy. The source of this element in foodstuffs is comprised in all those portions which are free from nitrogen. They are divided into two main classes —the *carbohydrates* and *fats*—and are identical with those found in the body, with the exception of starch and sugar, which are never found as such to any extent in the healthy body. The carbohydrates are sugar, gums, and woody fiber; the latter, in the statement of analyses of foods, is reported separately, while the remainder of the above are, in order to conform to the general usage, classed together under the head of "nitrogen-free extract." The gums play only a secondary part as regards the nutritive value of the food. The carbohydrates are first changed into fats, and then used as fuel; though it must be remembered that for the purpose of heat, fat is worth 2.25 times as much as carbohydrates (that is, 1 pound of fat is equivalent, when used as a fuel, to 2.25 pounds of starchy matter). When there is a deficiency in the amount of these elements in the food, the fat of the body is drawn npon.

The fat, as might be supposed, varies in amount more than any other substance of the animal body. The fat seldom falls below six, or rises above thirty per cent. If the supply is cut off, the surplus fat stored up in the body is drawn upon to keep the animal machinery going, and if this continues the protein is converted into fat and used as such. Thus, by having a proper proportion of fat in the food of the stock, not only is the fat of the body protected, but indirectly, also, the protein of the muscle and blood, which is most important.

The term fat includes the butter of milk, the fat of meats, oil of seeds, wax of plants, etc. It is determined by treating the perfectly dried substance with ether, the extract thus resulting being designated as "crude fat." As might be supposed, these ether extracts have different nutritive values—the fat from the green fodder being of less value than that from the meals and seeds. Some authorities, in estimating the nutritive effect of food, give to all the crude fats the same significance. The *use of fat* is mainly as a fuel supply to the animal body, although it may form fatty tissue, but *not muscle*.

In the following tables are given the analyses of the different foods which have been examined at this Station, and also those of some others, of practical interest to the feeders of this State, taken from Professor Henry's work on "Feeds and Feeding." Credit is due Messrs. Frank J. Snow and R. K. Bishop for assistance in the chemical work here reported.

TABLE I.—COMPOSITION OF FOODS.
Percentage Composition.

FEED STUFFS.	Water.	Ash.	Protein.	Fiber.	Starch, Sugar, etc.	Fat.
Green Fodder.						
Alfalfa	80.00	1.72	4.94	4.70	7.90	.74
Alfileria	80.00	1.72	2.83	4.72	9.81	.92
Australian saltbush	76.51	4.75	3.34	4.67	10.28	.45
Barley*	79.00	8.80	2.70	7.90	8.00	.60
Clover, red	70.80	2.10	4.40	8.10	13.50	1.10
Corn, Indian*	79.30	1.20	1.80	5.00	12.20	.50
Corn Kaffir*	76.13	1.75	3.22	6.16	11.96	.78
Cow pea*	83.60	1.70	2.40	4.80	7.10	.40
Flat pea	63.48	3.18	8.18	9.76	13.77	1.63
Horse bean *	84.20	1.20	2.80	4.90	6.50	.40
Hungarian grass*	71.10	1.70	3.10	9.20	14.20	.70
Marsh ("Briston") grass	50.00	2.83	5.14	12.76	27.72	1.55
Modiola decumbens	80.00	2.87	2.72	3.24	10.56	.61
Oats*	62.20	2.50	3.40	11.20	19.30	1.40
Orchard grass*	73.00	2.00	2.60	8.20	13.30	.90
Peas and oats	78.70	1.70	3.50	6.00	9.10	1.00
Rye*	76.60	1.80	2.60	11.60	6.80	.60
Sacalin, leaves	82.28	1.21	5.02	2.41	8.09	.99
Sacalin, stalks	82.09	.90	1.61	7.17	7.89	.34
Snail clover	81.25	2.07	2.85	4.66	8.41	.76
Soya bean*	75.10	2.60	4.00	6.70	10.60	1.00
Sorghum*	79.40	1.10	1.30	6.10	11.60	.50
Silage.						
Barley	74.00	2.49	2.56	8.96	10.76	1.23
Clover	72.00	2.60	4.20	8.40	11.60	1.20
Corn	75.36	1.57	2.10	6.39	13.78	.80
Oats	72.00	2.11	2.20	9.35	13.11	1.23
Orchard grass	77.00	2.00	1.87	9.12	8.64	1.37
Roots, Beet Pulp, etc.						
Artichokes*	79.50	1.00	2.60	.80	15.90	.20
Beet, mangels*	90.90	1.10	1.40	.90	5.50	.20
Beet, sugar	84.30	.90	1.80	.90	12.00	.10
Beet pulp, fresh	90.00	.36	1.15	2.11	6.25	.13
Beet pulp, silage	88.87	.45	1.50	3.55	5.40	.21
Beet molasses	25.70	8.80	7.30	....	58.20	....
Cabbage*	90.50	1.40	2.40	1.50	3.90	.40
Carrots*	88.60	1.00	1.10	1.30	7.60	.40
Olive pomace	17.30	1.75	7.61	42.67	13.11	17.56
Parsnips*	88.30	.70	1.60	1.00	10.20	.20
Pie melons	94.50	.40	.77	1.23	2.88	.22
Potatoes*	78.90	1.00	2.10	.60	17.30	.10
Pumpkins*	90.90	.50	1.30	1.70	5.20	.40
Sugar beet crowns	81.92	.81	1.91	1.91	13.38	.07
Sugar beet leaves	88.75	.67	1.91	1.42	7.22	.03
Sugar beet tops	87.14	.70	1.91	1.53	8.68	.04
Turnips*	90.50	.80	1.10	1.20	6.20	.20
Hay.						
Alfalfa	10.95	6.43	17.60	22.63	39.31	3.08
Australian saltbush	8.52	18.56	12.89	18.03	40.30	1.74
Barley, common	6.44	7.15	11.11	22.55	50.37	2.38
Barley, beardless	10.67	5.67	8.05	21.03	51.80	2.78
Clover, alsike*	9.70	8.30	12.80	25.60	40.70	2.90
Clover, bokhara	9.01	7.04	13.35	22.14	45.26	3.20

*From Henry: "Feeds and Feeding."

TABLE I.—COMPOSITION OF FOODS. (*Continued.*)
Percentage Composition.

FEED STUFFS.	Water.	Ash.	Protein.	Fiber.	Starch, Sugar, etc.	Fat.
Hay (*Continued*).						
Clover, bur	11.25	6.91	10.50	26.19	44.92	2.23
Clover, crimson*	9.60	8.60	15.20	27.20	36.60	2.80
Clover, red*	15.30	6.20	12.30	24.80	38.10	3.30
Clover, snail	10.15	9.92	13.65	22.34	40.29	3.65
Clover, white*	9.70	8.30	15.70	24.10	39.30	2.90
Clover, wild yellow	9.50	5.39	15.58	30.28	35.25	4.00
Cow pea*	10.70	7.50	16.60	20.10	42.20	2.20
Flat pea	10.00	7.83	20.16	24.05	33.94	4.02
Foxtail (*Hordeum jubatum*)	12.00	5.39	7.45	33.53	39.79	1.84
Hungarian grass*	7.70	6.00	7.50	27.70	49.00	2.10
Johnson grass*	10.20	6.10	7.20	28.50	45.90	2,10
Mixed cereal	7.65	5.91	7.30	24.80	51.59	2.75
Oat	10.09	7.00	7.44	24.80	48.22	2.45
Orchard grass*	9.90	6.00	8.10	32.40	41.00	2.60
Rye grass, perennial*	14.00	7.90	10.10	25.40	40.50	2.10
Soya bean*	11.30	7.20	15.40	22.30	38.60	5.20
Vetch*	11.30	7.90	17.00	25.40	36.10	2.30
Wheat	8.82	5.58	5.96	22.48	55.15	1.81
Wild hay, oat	10.00	5.59	5.70	37.19	39.25	2.28
Other Dry, Coarse Fodder.						
Alkali weed	13.40	9.25	12.30	17.30	44.25	3.50
Barley straw*	14.20	5.70	3.50	36.00	39.00	1.50
Corn fodder*	42.20	2.70	4.50	14.30	34.70	1.60
Gourd vines, "mock orange"	13.90	12.66	11.42	16.92	43.06	2.04
Lima bean straw	10.00	9.56	10.72	21.14	46.66	1.92
Oat straw*	9.20	5.10	4.00	37.00	42.40	2.30
Soya bean straw*	10.10	5.80	4.60	40.40	37.40	1.70
Wheat straw*	9.60	4.20	3.40	38.10	43.40	1.30
Grain and Other Seeds.						
Barley (rolled)	10.05	2.92	12.00	2.30	69.63	3.12
Broom corn	12.70	3.00	10.30	2.20	70.40	5.00
Bur clover seed	6.61	8.85	21,45	25.08	32.66	5.35
Corn, Indian*	10.60	1.50	10.30	2.20	70.40	5.00
Corn, Egyptian	12.63	1.92	9.96	1.93	69.70	3.86
Corn, Kaffir*	9.30	1.50	9.90	1.40	74.90	3.00
Cow pea*	14.80	3.20	20.80	4.10	55.70	1.40
Flaxseed*	9.20	4.30	22.60	7.10	23.20	33.70
Oats*	11.00	3.00	11.80	9.50	59.70	5.00
Rice	12.30	.30	8.40	....	78.60	.40
Rye*	11.60	1.90	10.60	1.70	72.50	1.70
Soya bean*	11.80	4.70	34.00	4.80	28.80	16.90
Sorghum*	12.80	2.10	9.10	2.60	69.80	3.60
Sunflower*	8.60	2.60	16.30	29.90	21.40	21.20
Wheat, plump	11.50	1.76	11.85	2.45	70.40	2.03
Wheat, shrunken	8.30	2.34	17.10	3.48	66.78	3.00
Mill and By-Products.						
Brewers' grains, dry*	8.20	3.60	19.90	11.00	51.70	5.60
Brewers' grains, wet	75.70	1.00	5.40	3.80	12.50	1.60
Cocoanut oil-cake meal	14.08	4.36	19.51	9.53	42.12	10.40
Corn meal	12.05	1.54	9.40	2.00	71.34	3.67
Cottonseed meal	9.85	4.86	47.25	3.19	22.64	12.21
Gluten feed*	7.80	1.10	24.00	5.30	51.20	10.60
Gluten meal*	8.20	.90	29.30	3.30	46.50	11.80

*From Henry: "Feeds and Feeding."

TABLE I.—COMPOSITION OF FOODS. (*Continued.*)

Percentage Composition.

FEED STUFFS.	Water.	Ash.	Protein.	Fiber.	Starch, Sugar, etc.	Fat.
Mill and By-Products (*Cont.*).						
Linseed oil-cake meal, N. P.	10.93	4.50	30.70	8.89	37.95	7.03
Linseed oil-cake meal, O. P.	9.35	5.22	29.75	6.23	31.20	18.25
Malt spouts	13.35	5.99	19.53	14.00	45.17	1.96
Mixed feed	10.57	3.57	12.00	9.66	59.98	4.21
Palm nut meal*	10.40	4.30	16.80	24.00	35.00	9.50
Pea meal*	10.50	2.60	20.20	14.40	51.10	1.20
Peanut meal*	10.70	4.90	47.60	5.10	23.70	8.00
Rice bran	10.55	6.64	14.96	4.85	50.20	12.80
Rice hulls	11.02	16.04	5.36	37.12	29.54	.92
Crushed barley	10.05	2.92	12.00	2.30	69.63	3.12
Rye bran*	10.60	3.60	14.70	3.50	63.80	2.80
Shorts	9.85	4.24	15.20	5.05	64.48	3.32
Wheat bran	11.67	5.18	14.05	8.16	57.34	3.60
Wheat middlings	11.73	2.85	15.22	4.88	60.85	4.47
Wheat screenings	11.67	2.94	10.06	5.48	67.63	2.72
†Miscellaneous.						
Blood meal	......	....	79.60	....	....	....
Distillery slops*	93.70	.20	1.90	.60	2.80	.90
Dried blood	8.50	....	84.40	....	....	2.50
Meat meal	7.50	....	42.90	....	....	....
Poultry food, Pratt's	14.63	6.19	13.52	5.35	55.91	4.40
Milk, whole	87.20	.70	3.60	....	4.90	3.70
Milk, colostrum	74.60	1.60	17.60	....	2.70	3.60
Skim milk, gravity	90.30	.70	3.30	....	5.30	.40
Skim milk, centrifugal	90.60	.70	3.30	....	5.30	.10
Buttermilk	90.30	.70	4.00	....	4.50	.50
Whey	93.40	.50	.80	....	5.00	.30

DIGESTIBILITY OF FOODS.

The chemical composition, alone, of the different food-materials is not of much value to the farmer or dairyman, if he does not know how much of each nutrient (the name given to the nutritive parts of the food—protein, fat, carbohydrates, and mineral matters) of the feeding-stuff in question is digestible, or available to the animal. Most of the experiments in this line have been made in Germany, although some of the Eastern States are now carrying on this kind of investigation.

In all foods there is always a certain portion of each nutrient, whether it be protein, fat, or carbohydrate, which is not digested or assimilated, but passes through the body, and is valuable only as manure. In order to ascertain how much of each food is not digested, the material is weighed and chemically analyzed before consumption, and the weight and composition of the animal excrement is also determined. The difference of the two analyses is taken as the quantity digested or assimilated. The results so obtained are termed *digestion coefficients*, and are only approximate, but, in the present

*From Henry: "Feeds and Feeding."

†The nutrients of the foods under this head may, for the purposes of this Bulletin, be considered as entirely digestible.

state of such researches, the best data available. For each food the digestion coefficient may vary considerably—the more concentrated the food, the higher, as a rule, will be the digestion coefficient. For instance, while about 57 per cent. of the protein is digestible in oat hay, 78 is the coefficient for grain middlings or bran, and in some of the peas and beans we find as much as 88 per cent. of this highly important ingredient to be digestible.

To illustrate the above statements: In every 100 pounds of alfalfa hay (average of three analyses) there are 17.60 pounds of crude protein, 3.08 pounds of crude fat, 39.31 pounds of nitrogen-free extract, and 22.63 pounds of crude fiber. For this hay, according to the latest investigations, it has been found that of the protein about 70 per cent. is digestible; of the fat, 51 per cent.; of the crude fiber, 46 per cent.; and about 68 per cent. of the nitrogen-free extract can be digested. Hence, in 100 pounds of alfalfa hay there would be 12.32 pounds of digestible protein, 1.57 pounds of digestible fat, 26.73 pounds of digestible nitrogen-free extract, or starchy material, and and 10.40 pounds of digestible fiber.

Nutritive Ratio.—The different feeding stuffs vary very much in their composition; peas and beans, and the concentrated foods in general, contain large amounts of protein, or muscle-forming ingredients, and very little of the non-nitrogenous materials; others, like the potato, corn, etc., have much starchy matter combined with small quantities of albuminoids; and, again, as in the case of the vegetables as a whole, we have small amounts of both carbohydrates, or fat-producers, and nitrogenous, or muscle-formers.

The proportion of these two important elements of the cattle foods is termed the *nutritive ratio;* in other words, the latter is the ratio of the digestible protein to the sum of all the remaining nutrients in the food. In estimating this sum, the figure denoting the amount of fat is multiplied by 2.25, because it has been ascertained by experiment, as before stated, that about 2.25 times as much heat is developed by the consumption of a pound of fat as by the same quantity of sugar or starch. This product is added to the weight of the carbohydrates, and the sum divided by the figure for the protein, the quotient being the nutritive ratio.

To illustrate this: Let us take, again, alfalfa hay, which contains, as previously noted, 12.32 per cent. of digestible protein, 1.57 per cent. of fat, 26.73 per cent. of digestible nitrogen-free extract, and 10.40 per cent. of digestible fiber. The fat percentage (1.57), multiplied by 2.25, amounts to 3.53; this added to the figure for the fiber and carbohydrates, 37.13, equals 40.66, which divided by 12.32, the per cent. of protein, gives 3.3. Hence the nutritive ratio is 1:3.3; in other words, there is in alfalfa hay 1 part of protein, or nitrogenous matter, to 3.3 parts of non-nitrogenous, or starchy material. The ratio is "wide," and termed a carbonaceous one, when the amount of protein to the remaining ingredients is small. A "narrow," or nitrogenous ratio, is one where the reverse is the case; that is, the amount of protein is considerable when compared with that of the carbohydrates, as in the example just given.

The data for the total dry matter and digestible nutrients in 100 pounds of the different feedstuffs, are presented in table II.

TABLE II.—DRY MATTER AND DIGESTIBLE NUTRIENTS IN 100 POUNDS.

FEED STUFFS.	Dry Matter in 100 lbs.	DIGESTIBLE NUTRIENTS IN 100 LBS.			Nutritive Ratio.
		Protein.	Carbo-Hydrates.	Fat.	
Green Fodder.					
Alfalfa	20.0	3.7	7.3	.6	1: 2.3
Alfileria	20.0	2.1	8.5	.7	1: 4.8
Australian saltbush	23.5	2.5	9.2	.3	1: 3.9
Barley	21.0	1.9	10.2	.4	1: 5.8
Clover, red	29.2	2.9	14.8	.7	1: 5.6
Corn, Indian	20.7	1.0	11.6	.4	1:12.5
Corn, Kaffir	23.9	1.7	12.1	.6	1: 8.0
Cow pea	16.4	1.8	8.7	.2	1: 5.1
Flat pea	56.5	6.2	14.2	1.0	1: 2.4
Horse bean	15.8	2.2	7.1	.2	1: 3.5
Hungarian grass	28.9	2.0	16.0	.4	1: 8.5
Marsh ("Briston") grass	50.0	2.6	24.4	.9	1:10.2
Modiola decumbens	20.0	1.8	9.0	.5	1: 5.3
Oats	37.8	2.6	18.9	1.0	1: 8.1
Orchard grass	27.0	1.5	11.4	.5	1: 8.3
Peas and oats	16.0	1.8	7.1	.2	1: 4.2
Rye	23.4	2.1	14.1	.4	1: 7.1
Sacalin, leaves	17.7	3.8	6.3	.8	1: 2.1
Sacalin, stalks	17.8	.8	7.5	.2	1:10.0
Snail clover	18.8	2.0	8.2	.6	1: 4.7
Soya bean	24.9	3.2	11.0	.5	1: 3.8
Sorghum	20.6	.6	12.2	.4	1:21.8
Silage.					
Barley	26.0	1.8	12.7	.9	1:11.7
Clover	28.0	2.0	13.6	1.0	1: 7.9
Corn	24.6	1.3	13.5	.6	1:11.7
Oat	28.0	1.5	14.8	.9	1:11.0
Orchard grass	23.0	1.1	10.6	1.0	1:11.4
Roots, Beet Pulp, etc.					
Artichokes	20.0	2.0	16.8	.2	1: 8.7
Beet, mangels	9.1	1.1	5.4	.1	1: 5.1
Beet, sugar	15.7	1.6	11.9	.1	....
Beet pulp, fresh	10.0	.9	7.3	.1	1: 8.2
Beet pulp, silage	11.1	1.2	7.7	.2	1: 6.8
Beet molasses	74.3	3.7	52.4	....	....
Cabbage	15.3	1.8	8.2	.4	1: 5.1
Carrots	11.4	.8	7.8	.2	1:10.4
Parsnips	11.7	1.6	11.2	.2	1: 7.3
Pie melons	5.5	.7	3.3	.2	1: 5.4
Potatoes	21.1	.9	16.3	.1	1:18.4
Pumpkins	9.1	1.0	5.8	.3	1: 6.6
Sugar beet crowns	18.1	1.7	12.7	.07	1: 7.5
Sugar beet leaves	11.3	1.7	4.6	.03	1: 2.7
Sugar beet tops	12.9	1.7	6.5	.05	1: 3.8
Turnips	9.5	1.0	7.2	.20	1: 7.7
Hay.					
Alfalfa	89.1	12.3	37.1	1.6	1: 3.3
Australian saltbush	91.5	6.5	36.8	1.0	....
Barley, average	91.5	5.8	43.1	1.6	1: 8.1
Clover, alsike	90.3	8.4	42.5	1.5	1: 5.5
Clover, bokhara	91.0	8.7	39.4	1.9	1: 5.0
Clover, bur	89.9	7.3	41.2	1.8	1: 6.2
Clover, crimson	90.4	10.5	34.9	1.2	1: 3.6

TABLE II.—DRY MATTER AND DIGESTIBLE NUTRIENTS IN 100 POUNDS. (*Continued.*)

FEED STUFFS.	Dry Matter in 100 lbs.	DIGESTIBLE NUTRIENTS IN 100 LBS.			Nutritive Ratio.
		Protein.	Carbo-Hydrates.	Fat.	
Hay (*Continued*).					
Clover, red	84.7	6.8	35.8	1.7	1: 5.8
Clover, snail	89.9	9.6	39.4	1.8	1: 4.5
Clover, white	90.3	11.5	42.2	1.5	1: 4.0
Clover, wild yellow	90.5	10.1	36.6	2.4	1: 4.1
Cow pea	89.3	10.8	38.6	1.1	1: 4.7
Flat pea	90.0	15.3	36.0	2.4	1: 2.7
Foxtail	88.0	4.3	41.4	.9	1:10.1
Hungarian grass	92.3	4.5	51.7	1.3	1:12.1
Johnson grass	89.2	3.2	42.3	.8	1:13.8
Mixed	92.4	4.4	47.3	1.7	1:11.5
Oat	89.9	4.5	43.7	1.5	1:10.5
Orchard grass	90.1	4.9	42.3	1.4	1: 8.3
Rye grass, perennial	86.0	6.1	37.8	1.2	1: 6.6
Soya bean	88.7	10.8	38.7	1.5	1: 3.9
Vetch	88.7	12.9	37.5	1.4	1: 3.2
Wheat	91.2	3.6	46.1	1.1	1:13.2
Wild hay	90.0	3.4	44.1	1.1	1:13.6
Other Dry, Coarse Fodder.					
Alkali weed	86.6	5.5	38.6	2.2	1: 7.8
Barley straw	85.8	.7	41.2	.6	1:60.8
Corn fodder	57.8	2.5	34.6	1.2	1:15.0
Gourd vine, "mock orange"	86.1	5.1	37.5	1.3	1: 7.8
Lima bean straw	90.0	5.4	38.8	1.2	1: 7.7
Oat straw	90.8	1.2	38.6	.8	1:33.6
Soya bean straw	89.6	2.3	40.0	1.1	1:18.4
Wheat straw	90.4	.4	36.3	.4	1:93.0
Grains and Other Seeds.					
Barley (crushed)	90.0	9.6	63.5	2.1	1: 7.1
Broom corn	87.3	8.1	61.6	3.0	1: 8.4
Bur clover seed	93.4	17.2	38.7	4.3	1: 2.8
Corn, Indian	89.4	7.8	66.7	4.3	1: 9.8
Corn, Egyptian	87.4	8.0	64.3	3.0	1: 8.9
Corn, Kaffir	90.7	7.5	70.5	2.6	1:10.3
Cow pea	85.2	18.3	54.2	1.1	1: 3.1
Flaxseed	90.8	20.6	17.1	29.0	1: 4.0
Oats	89.0	9.2	47.3	4.2	1: 6.2
Rice	87.7	5.3	67.6	.3	1:11.8
Rye	88.4	9.9	67.6	1.1	1: 7.1
Soya bean	89.2	29.6	22.3	14.4	1: 2.0
Sorghum	87.2	7.0	52.1	3.1	1: 8.4
Sunflower	92.5	12.1	20.8	29.0	1: 7.1
Wheat, plump	88.5	9.5	49.9	1.4	1: 5.6
Wheat, shrunken	91.7	13.7	47.6	1.4	1: 3.7
Mill and By-Products.					
Brewers' grains, dry	91.8	15.7	36.3	5.1	1: 3.0
Brewers' grains, wet	24.3	3.9	9.3	1.4	1: 3.2
Cocoanut oil-cake meal	85.9	16.4	42.4	9.7	1: 3.9
Corn meal	88.0	6.4	66.3	3.4	1:11.5
Cottonseed meal	90.2	41.1	15.4	11.0	1: 1.0
Gluten feed	92.2	20.4	48.3	8.8	1: 3.3
Gluten meal	91.8	25.8	43.3	14.0	1: 2.9
Linseed oil-cake meal, N.P.	89.1	26.1	38.5	6.5	1: 2.0
Linseed oil-cake meal, O.P.	90.7	24.4	24.0	16.7	1: 2.5

TABLE II.—DRY MATTER AND DIGESTIBLE NUTRIENTS IN 100 POUNDS. (*Continued.*)

Feed Stuffs.	Dry Matter in 100 lbs.	Digestible Nutrients in 100 Lbs.			Nutritive Ratio.
		Protein.	Carbo-Hydrates.	Fat.	
Mill and By-Products (*Cont.*).					
Malt sprouts	86.7	15.6	35.8	2.0	1: 2.6
Mixed feed	89.4	9.6	47.4	3.0	1: 5.6
Palm nut meal	89.6	16.0	52.6	9.0	1: 4.6
Pea meal	89.5	16.8	51.8	.7	1: 3.2
Peanut meal	89.3	42.9	22.8	6.9	1: 0.9
Rice bran	89.5	10.7	41.8	10.6	1: 5.9
Rice hulls	89.0	2.7	30.8	.8	1:12.1
Crushed barley	90.0	9.6	63.5	2.1	1: 7.1
Rye bran	88.4	11.5	50.3	2.0	1: 4.8
Shorts	90.2	12.2	47.9	2.9	1: 4.5
Wheat bran	88.3	11.2	42.2	2.5	1: 4.3
Wheat middlings	88.3	12.2	53.4	3.8	1: 5.1
Wheat screenings	88.4	8.1	48.7	1.8	1: 6.6

POTENTIAL ENERGY.

The measure of food as regards its fuel value is made in terms of "potential energy," the unit of which is the *calorie*, or the amount of heat necessary to raise the temperature of a kilogram of water 1° Centigrade, or one pound of water 4° Fahrenheit. Instead of this unit we may use a unit of mechanical energy, the foot-ton, which is the force that would lift one ton one foot, one calorie being equal to about 1.53 foot-tons.

Professor Rubner found, in experiments made in the physiological laboratory at Munich, the quantities of materials which were equal to 100 of fat to be as follows:

Nutritive Substances, Water-Free.	As determined by direct experiment with Animals.	As determined by Calorimeter.
Myosin (proteid of meat)	225	213
Lean meat	243	235
Starch	232	229
Cane sugar	234	235
Grape sugar	256	235

Taking the ordinary food materials as they come, the following general estimate has been made for the average amount of energy in one gram of each of the classes of nutrients:

Potential Energy in Nutrients of Food.

	Calories.	Foot-Tons.
In one gram protein	4.1	6.3
In one gram fats	9.3	14.2
In one gram carbohydrates	4.1	6.3

These figures mean that when a gram of fat is consumed, be it fat of the food or body fat, it will, if its potential energy be all transformed into heat, yield enough to warm 9.3 kilograms of water 1° Centigrade, or, if it be transformed into mechanical energy, such as the muscles use to do their work, it will furnish as much as would raise one ton 14.2 feet, or 14.2 tons one foot. The potential energy of the protein or carbohydrates is less than one-half that of the fat. These figures, as stated by Professor Atwater, are not absolutely accurate, and may be revised by future research in the subject.

COMMENTS ON VARIOUS FEED-STUFFS.

SILAGE AND VEGETABLES.

One of the chief requisites of a ration for profitable milk-production is that it be succulent, by which is meant that a portion of the ration contains a large percentage of water. This watery condition, or succulency, adds to the palatability of the food, and also seems to have a beneficial physical effect upon the animal digestion. The cow, therefore, eats a larger quantity of food, digests and assimilates it more thoroughly, and consequently gives a larger flow of milk. Although the major portion of California does not have the long cold winters to which the Eastern States are subject, and where it is an absolute necessity to store large quantities of food, both succulent and dry, still every section of our State has a longer or shorter period during the year when pastures are dry. The provident dairyman, therefore, anticipates these dry months, and either lays in a store of green food beforehand, or has some growing which he may cut and feed to his cattle.

Roots.—Several of the vegetables are valuable in supplying succulence for the ration. Among the root class the one in most common use is the mangel wurtzel beet, because very large quantities can be grown per acre and because it is palatable to all kinds of live stock. Carrots are also used in some sections, and they have the advantage of containing a slightly larger amount of dry matter than mangels. Of all the roots, moreover, none are more relished by horses than carrots. Sugar beets are not found profitable to grow for feeding stock, because they yield so small a tonnage in comparison to mangels, and the greater cost of growing and gathering can only be undertaken on the ground of their greater value for sugar. Potatoes contain about twice as much dry matter as mangels and three times as much carbonaceous material. They are, therefore, of greater food value, but, like sugar beets, have too high a commercial value as human food to make them profitable for stock.

Squashes.—Another class of vegetables which are useful and easily grown is that of the melons or squashes. A very familiar example is the so-called *pie-melon*, an analysis of which is found in Table I. This, like the ordinary field pumpkin, can be produced readily in large quantities on most lands, and it ripens at a time when green food is likely to be scarce. All of these vegetables when fed to dairy stock produce an increased milk yield, which is more than commensurate with their actual content of food substance. This is because of their palatability, beneficial effect upon digestion, and the addition of a wholesome variety to the ration. Any of the vegetables named may be fed with profit to swine and poultry when in confinement, and to sheep especially during the nursing period.

Silage.—One of the most economical means of preparing succulent food for seasons of drought and for supplementary feeding is by the use of the silo. It is, no doubt, generally understood that the silo, as at present constructed, is a huge tank having perpendicular walls and

being made as nearly air-tight as is convenient. The usual size for the silo is fifteen to twenty feet in diameter and thirty feet high. Into the silo is put the green fodder immediately after being cut fresh in the field. The most common crop for ensiling is Indian corn, which is, moreover, the most profitable plant to grow for this purpose. At one harvest it furnishes a larger tonnage per acre than any other crop. The stalks, which if cured dry would be largely wasted, are kept in so soft a condition in the silo as to be completely eaten by the stock. Other plants, such as alfalfa, barley, oats, and orchard grass, are sometimes ensiled, but we would not recommend their general use except in seasons or localities where corn may not at the time be available, or in case they might otherwise be rendered more or less useless if cured dry; as, for example, the first cutting of alfalfa with its usual mixture of foxtail. Almost any plant grown on the ranch may be ensiled. The chief question is, what can be most profitably made the main crop for the purpose? The proof is abundant that Indian corn is the most profitable. The sorghums and sweet corn do not answer well for ensiling because of their high content of sugar, resulting in too much fermentation in the silo.

No better combination of foods for feeding cows in the stable can be imagined than alfalfa hay and corn silage, and possibly a little grain, although a fairly well-balanced ration can be made up without grain. In such feeding it is best to give hay and silage each once a day. The amount of silage per head ranges from thirty-five to sixty pounds daily, depending upon the size and appetite of the animal and upon the supply of silage. The cattle will eat corn silage at all seasons of the year, even when on good alfalfa or other green pasture; but if the supply be limited it can be most profitably fed when pastures are dry, or if the cattle should be kept off them because of heavy rains or until the grass is of sufficient age and size to be of value. If the dairymen will erect silos and have their cows calve in the fall instead of spring they can secure as large a flow of milk during the season when dairy products are usually high-priced as they now have during the low prices of the spring months. Corn silage may be fed with profit to sheep as well as cattle, but not to other stock. Alfalfa silage is fed successfully to all farm stock, including swine and poultry. Horses working hard should be given such watery food in very small quantities; while those at light work or doing nothing may be fed more, and will even make profitable use of some corn silage.

Soiling.—Another method of providing succulent food is to cut the fodder green and feed immediately to the stock. This method is known as "soiling." Any of the ordinary fodder plants may be used in this way—the most common being any of the corns, sorghums, oats and peas, cereal grasses and the like. If this practice is followed the same rule would apply as in the case of silage—to raise the crop which will produce the most and best food per acre. "Soiling" presupposes that the stock are being kept in small pastures or in corrals, or at least have but little feed on their range. It also calls for more labor than is necessary if the stock could harvest their own food, but less land is required to maintain the same number of cattle than if they depended wholly upon pasturage. The matter then lies between soiling on the one hand with less land and more labor, and pasture on

the other with more land and less labor. With plenty of land available and labor high, we do not expect an extended adoption of the soiling method in California for some years to come. The more general use of the silo will also tend to reduce the soiling period, because experience shows that it is cheaper to provide green food for the year by one filling of the silo than by the daily cutting of standing fodder.

ALFALFA.

The large amount of alfalfa grown in the interior valleys of the State and its great value as a stock food render it an important element in the development of the animal industries, and one worthy of careful study and experimentation. Two factors make alfalfa of great use to the farmer and stockman—one is the large yield of pasture or hay that he can produce during the year, and the other is the high content of protein which alfalfa contains. Alfalfa hay of good quality carries so much of this important and usually costly element that a glance at the tables of analyses shows that twenty pounds of hay contains as much protein as is required in the balanced ration of an ordinary sized milch cow. Table III also shows the relative amount of digestible protein in a ton of material and the cost of protein per ton of the various common feedstuffs and of the more common hays. These comparative figures show how valuable a fodder alfalfa is. Almost all of the coarse fodder grown upon the ranch is relatively rich in carbohydrates and relatively poor in protein. This is particularly true of the cereal hays, straw, corn fodder and the like. With these only the feeder cannot make a good ration, and what he needs to buy is protein. He usually buys concentrated foods because of their richness in protein, and also pays for them on the basis of their protein content. Were he able to raise alfalfa or to buy it at a reasonable price, he could feed his cattle much more cheaply, and undoubtedly with as good results. This fact is brought out by Table III, showing the relative cost of protein per pound as furnished by the different foods. These prices are taken to represent as nearly as possible the market values at the time of writing. Calculations of this kind can never be arbitrary, owing to the fluctuation in prices, but they show how the careful purchaser may be able to compare food values at any season of the year.

TABLE III.—Cost of Protein in Various Foods as Governed by the Cost of the Food and its Content of Digestible Protein.

Food.		Protein.	
	Price per ton.	Pounds per ton.	Price per pound.
	Dollars.		Cents.
Corn	26.00	156	16.7
Wheat	20.00	190	10.5
Barley	17.00	192	8.8
Oats	25.00	184	13.6
Rye	18.00	198	9.1
Wheat bran	17.00	224	7.6
Wheat shorts	16.00	244	6.6
Wheat middlings	18.00	244	7.4
Rice bran	14.00	214	6.5
Rye bran	14.50	230	6.3
Coacoanut oil-cake meal	17.00	328	5.2
Linseed oil-cake meal	25.00	522	4.8
Cottonseed meal	30.00	822	3.7
Mixed feed	15.00	192	7.8
Malt sprouts	15.00	312	4.8
Alfalfa hay	8.00	246	3.3
Wheat hay	9.00	72	11.1
Barley hay	9.00	116	7.8
Oat hay	9.00	90	10.0
Straw	3.00	16	19.0
Corn silage	2.00	26	7.7

We are not yet prepared to say that by the liberal feeding of alfalfa, concentrated foods may be dispensed with entirely. As a general principle it would seem that a small amount of grain could be profitably fed at all times. Much and careful experimentation is needed to decide the often-asked question, "Does it pay to feed grain with alfalfa?" We hope to be able to undertake this experimental work in the near future.

SALTBUSHES.

The saltbushes have a two-fold value in that they are not only valuable forage plants but can be cultivated in soils containing alkali beyond the limit of tolerance for any other plant of similar food-value. Of these the *atriplex semibaccata* is the only one which has received any extended attention in this State.

It is specially worthy of mention that while the saltbushes differ materially botanically, and are not of equal adaptation, there is very little preference so far as chemical composition is concerned. But much further experimentation will be required before the same can be said of them physiologically, or with respect to nutritive values.

The choice of the best variety for a special locality would depend on soil adaptation and the results of feeding experiments.

Hays.—An examination of the analyses of the air-dried materials shows that the saltbushes compare very favorably in nutritive value with the other hays mentioned in table I. The average protein content, 12.89, is twice that noted for wheat hay, 50 per cent. more than the figure given for oat hay, and is only exceeded by bur clover and alfalfa. The average percentages of fat and starchy matter in

the saltbushes are less than those found in cereal hays. But in the case of the latter nutrient, the average is almost identical with the figures named for alfalfa and bur clover.

Digestibility.—As before stated, much more experimentation is required before we can definitely assert that these saltbushes have as high digestive coefficients as alfalfa and the ordinary hays. Feeding experiments are called for in this direction, and in some cases urgently so.

In making up a ration we would assign to the saltbush hay about the same digestive coefficients as those for oat hay. The digestibility would be greatly increased if the material were cut into small pieces, as it is a well-known fact that much more nutriment is derived from a given amount of fodder, more particularly by the horse and other solipeds, if it is cut up than if fed as harvested. This has been practically proved by many of the large livery stables, both here and abroad.

Feeding.—It is not advisable to feed the saltbushes alone, particularly in the air-dried state, owing to the high percentage of saline ingredients, and the general uninviting appearance and condition of the saltbush hay. In cases of emergency, however, sheep and cattle have existed altogether on this material through an entire season.

Mixed vs. Unmixed Foods.—From the large number of favorable reports, it would seem that many of the failures were due mainly to irrational feeding. In some cases animals which had never seen the salt-bush were given quantities of the unmixed material and were expected to eat it with relish. Such a method of procedure is, to say the least, ill advised. Any alteration in the food should be slow and gradual. It would be most unwise to substitute *A. semibaccata* for a cereal hay. The better plan would be to feed a very small amount of saltbush with considerable hay; then increase by degrees the quantity of saltbush and decrease that of cereal hay until the proportions are about equal. If the green saltbush were used, then the hay should constitute about one-third of the roughage of the ration.

Utilization of Straw.—The value of straw as a dilutant is becoming more appreciated every year. But it must be remembered that straw is dry, fibrous, and unpalatable, and consequently requires a succulent material to be used in conjunction with it. For this reason it is not desirable to feed the *saltbush hay* with straw. The green, however, could very advantageously be utilized, more particularly if both feeds were cut up and well mixed. By this method the farmer is not only able to use alkali land which has been considered worthless, but can use in conjunction with the crop from this land another material which has been deemed of little feeding value. The economy of this plan is apparent without discussion.

Silage and the Saltbush.—Silage could be fed profitably with either the green or air-dried saltbush; in the latter case, the dryness of the saltbush would be offset by the succulency of the silage. The amount of silage to be fed per day would depend greatly on the animals and the supplementary materials of the ration. The succulency of the fresh saltbush would be preserved and the digestibility of some of its fibrous parts increased if it were siloed. With some other material a salty relish would thus be imparted to the silage.

OTHER COARSE FODDERS.

Alkali Weed.—The *Centromadia pungens*, commonly called the yellow-blossoming alkali weed, or tall tar-weed, grows luxuriantly, attaining a height of from four to six feet on lands of the San Joaquin valley which are not too strongly contaminated with alkali. In this respect it materially differs from the *Atriplex semibaccatum*, or Australian saltbush, which thrives on soils so heavily impregnated with alkali that other cultures are not possible.

A comparison of the amounts of this fodder digestible with some well known and commonly used hays would emphasize the value of this plant for stock feeding. The total nutriment, as indicated by the fuel value in one pound, 919 calories, would place this feed-stuff low on the list. But when we compare its digestible flesh-formers, 6.15 pounds, with the corresponding content of other hays; we note that it rates almost as high as barley hay which stands second; alfalfa ranking first with 12.30 pounds, or about twice that given for either barley hay or the alkali weed. Hence we see that the more of the alkali weed that can be used in the ration the more highly nitrogenous will it be and consequently the more beneficial for the animal.

Experience has shown that stock will not eat *Centromadia* in the green state. This fact may be due to the presence of an essential oil and resin which probably disappears during the drying or curing of the plant, or to the spiny tips on the leaves, similar to those found on the thistle, which soften as the plant becomes older and dryer. By siloing the green material the above objections might be overcome and most certainly would be if the spiny tips were the trouble. If no unpleasant flavors are imparted to the milk by the use of this weed, then the dairyman has in the *Centromadia pungens* a most valuable addition to his list of feed-stuffs.

Gourd Vines (Cucurbita foetidissima).—This vine is sometimes called mock orange. During the past dry seasons it has served in the southern part of the State as a substitute for hay, and, according to some reports, to good advantage. This plant admits of two or three cuttings annually.

A glance at the analysis, given in table I, page 5, shows that, chemically speaking, this fodder is a rich one, but we are ignorant of its physiological value; that is, we do not know just how much of the different nutrients are digestible by cows and horses. The figures stated for the amounts digestible in 100 pounds have been calculated on the assumption that these vines are as digestible as dried corn fodder. On that basis there is as much nutriment in the gourd vines as in any of the cereal hays.

Foxtail.—In this connection it is of interest to note the feeding value of foxtail (barley grass), which, when considered as hay, is found of equal nutritive value to oat hay. A ration made up wholly of alfalfa and foxtail hays in the proportion of 15 pounds of alfalfa to 12 pounds of foxtail, would have approximately the same composition and food value as ration No. 3 above, of alfalfa and barley hays. Owing, however, to the disagreeableness and injury to animals from the beards of the foxtail when dry, its chief value to the stockman is as pasture or as silage, where the beards are so softened as to render

them harmless. On account of the richness of foxtail in carbonaceous material as compared to alfalfa, the latter is made a more useful ration by the presence of foxtail if it can be fed either in green pastures or from the silo.

GRAINS AND BY-PRODUCTS.

Plump and Shrunken Wheat.—"Which is the better feed for laying hens, shrunken or plump wheat," is a question which has been agitating a number of poultry men in this State, and to intelligently answer it two samples of wheat received from Hanford have been analyzed, with the result that in the plump wheat the percentage of starch, etc., is considerably higher than the corresponding figure for the shrunken wheat; while the reverse is noted for the rating of protein, that of the latter sample being almost 50 per cent. greater than that yielded by the former, as is seen by the figures 17.10 and 11.70 per cent., respectively. This fact alone is sufficient to warrant a feeder purchasing shrunken in place of plump wheat as a food for laying hens.

It is barely possible that the digestion-coefficient for protein in the shrunken wheat may not be as high as that for the plump, but this question we will settle at the earliest opportunity by a digestion experiment with our hens. It must not be forgotten, however, that the figure 11.70 for albuminoids in the plump wheat is a trifle below the average; and while another example of two similar wheats would in all probability show the shrunken sample to be richer in nitrogen, there might not be such a marked difference as we have between the two lots under discussion.

Wheat, Bran, Middlings, Etc.—Throughout the whole country no grain product is used more universally for stock feeding than the by-products of wheat, the chief of which are bran and middlings. This is partly due to the fact that wheat is almost wholly used for human food, and in the manufacture of the best grades of flour the bran and middlings must be removed. Another feature which renders them so popular is that they are relished by all kinds of live stock, and that in the case of bran it may be fed *ab libitum* without injury to the animal. Our analyses show the middlings to be slightly richer in the various nutrients than bran, but the proportion of the nutrients is such that bran has the narrower nutritive ratio. Bran contains much more fiber than middlings, and is so much coarser that it is not so well adapted to feeding pigs and very young calves. Pigs do not relish foods as coarse as bran, oats, and the like, and it is therefore better economy to provide them with the finer materials like middlings. One feature of bran often overlooked is its high content of mineral matter. This, together with its richness in protein, makes it one of the most desirable foods for growing stock, as calves or colts, where bone and sinew need to be developed.

"*Shorts*" are classed among the by-products of wheat, and are shown by our analysis to have very nearly the same composition as middlings. The two names, middlings and shorts, are often used interchangeably, referring to the same article. Shorts sometimes consist largely of ground-over bran with some of the finer portions of ground wheat mixed in. For young pigs and calves middlings are

the more certain article to depend upon, while for older animals shorts may be used instead, if the price warrants.

"*Mixed feed*" is a very uncertain article, and depends for its value more upon the honesty of the manufacturer than upon the name. It may be of good material, as our analysis shows it to be, or it may contain large quantities of mill-sweepings, ground oat-hulls and other matter of little value.

Gluten Feed and Gluten Meal.—These are two by-products resulting from the manufacture of starch and glucose from corn. The corn grain may be roughly analyzed as follows: first is the outside layer of bran or hull; next comes a hard, flinty layer, which is very rich in protein, and which is called the gluten layer; inside this coating we find the main portion of the kernel, consisting chiefly of starch, and finally the germ of the seed. In the process of manufacturing starch and glucose the hull, gluten layer and germ are thrown aside. When all three are mixed together we have what is known in the market as "gluten feed." When the gluten layer is kept separate we have what is known in the market as "gluten meal." The hull of the corn is of comparatively little food value because of its coarse fibrous nature. The germ is rich in protein and fat, and is readily digested. In order to dispose of the hulls to advantage, the manufacturer mixes and grinds them with the germs and gluten layers, and he often does the animal no unkindness in the operation. The gluten layer alone, or gluten meal, is a very rich and heavy material, and should not be fed in larger quantities than three or four pounds per day. It is therefore sometimes fed to the injury of the animal by careless or inexperienced men. Gluten feed, however, because it contains the hulls, is a lighter material, not so rich, and may safely be fed in larger quantities up to six or seven pounds per day. It contains about twenty per cent. of digestible protein, while the gluten meal contains about twenty-five per cent. They are both, therefore, of great value as furnishers of protein for farm stock.

While this is the general distinction between gluten feed and gluten meal, the various manufacturers have introduced so many private and trade names that the purchaser is not always sure of his article until he sees it. Some of the more common names are "Chicago Gluten," Buffalo Gluten" "Cream Gluten," and the like. The chances are, however, that the buyer will obtain gluten *feed* as described above unless he makes an especial request for gluten *meal*. So far as we know, neither of these foods is in the California market, but their value will undoubtedly lead our dairymen to call for them before many years have passed.

Oil-Cake Meals.—The principal value of these meals lies in the high percentage of protein which they contain. The richest of all in this element is cottonseed meal, which, according to our analysis, shows 41.1 per cent. of digestible protein. "New process (N.P.)" linseed meal shows 26.1 per cent., "old process (O.P.)" linseed meal shows 24.4 per cent., and cocoanut meal 16.2 per cent.

Cocoanut meal is a by-product resulting from the extraction of oil from the cocoanut of commerce. So far as the United States is concerned, it is distinctively a Pacific Coast article, as it is not much known east of the Rockies. The present market price is about the

same as wheat bran, and since it contains 16.4 per cent. of digestible protein as against 11.2 per cent for bran, the cocoanut meal is much the cheaper to purchase as a furnisher of the nitrogenous element. It cannot, however, be fed so freely as bran, and it is doubtful if more than four pounds daily per head can be safely fed for any length of time. The one objection to cocoanut meal is its lack of keeping qualities. It is likely to become rancid if stored for several weeks, in which condition it is not relished by the stock, and if fed to dairy cows is apt to flavor the milk. When fresh it has a sweet and nutty flavor, which is highly relished by all stock.

The *linseed meals* are a by-product from the extraction of oil from flaxseed. The "old process" meal is the result of such extraction by means of pressure, while by the new process the oil is dissolved out of the ground flaxseed by means of naphtha. The odor of naphtha is afterwards driven off by steaming. In the new process the oil is more thoroughly extracted, and thus less remains in the meal than by the old process. The analysis of "old process" linseed meal in Table II is of one sample, and can hardly be taken as an average of this class of meals. The linseed meals have a laxative effect upon the digestion, and thus it is not well to feed more than two pounds per head daily to dairy cows. They tend also to make a soft butter fat. When fed in normal quantities they are very beneficial to the animal digestion, and impart a soft glossy appearance to the hair, and therefore become a useful portion in the rations of all farm stock.

Cottonseed meal comes to us from the cotton-growing States as a by-product from the extraction of oil from cottonseed. It is not quoted in our market, but dealers in feeding stuffs tell us that they will order it for any party or parties who will use a carload or more. In sections where alfalfa is not grown or readily obtained, cottonseed meal is one of the cheapest foods to buy to furnish protein, as shown in Table III. This is true although its price in the market may be higher than that of any of the other concentrated foods. Three pounds of this meal furnishes nearly half as much protein as is required in the day's ration of an average-sized cow. Thus it is not usual that more than two pounds per head be fed in addition to the protein which is provided by the other part of the ration. It is not well to give more than four pounds per head, on account of the constipating effect of the meal upon the animal. In feeding dairy cows it is also found to produce a hard butter fat. Cottonseed is most largely used for cattle feeding, both beef and dairy, and with invariably good results. It has proven so detrimental to swine of all ages and to young calves, that deaths have been reported as resulting from feeding it to them. So far as we know it has not been experimented with to any extent in feeding horses.

SUGAR-BEET TOPS, MOLASSES, AND PULP.

Sugar-Beet Tops.—It is stated by some feeders that sugar-beet tops is one of the best feeds available for the production of a firm butter. The Station expects in the near future to make some elaborate chemical tests on such butters.

The sugar-beet tops consist of leaves and crowns of the root (all

that part which has a greenish tinge), in the proportion of 76 per cent. of leaves and 24 per cent. of crown.

The analyses of leaves, crown, and tops are given in Table I.

An inspection of the figures showing the composition and nutritive value of the sugar-beet tops shows that water constitutes about seven-eighths of this material. One hundred pounds of the fresh substance is found to contain 8.25 pounds of digestible nutrients, proportioned as follows: protein, 1.71 pounds; carbohydrates, 6.49 pounds; and fat, .05 of a pound, with a valuation of $1.58. The analysis and valuation previously published were obtained from an Eastern source; our late work proves the tops to rate the same for protein, but to be slightly richer in carbohydrates, thus increasing the value from $1.40 to $1.58. The fertilizing value is about $1.65.

From these figures we see that the material as such is worth more as a fertilizer than as a cattle food. The above estimate of the tops as a fertilizer does not include the vegetable matter, which as a green-manure has considerable value. But it is said that if the tops are used as a food and the manure saved, about three-fourths of the fertilizing value of the original substance is still retained. While this is true theoretically, it is hardly ever so practically; particularly with reference to the nitrogen, the most costly of the fertilizing elements.

In very few instances, unless the animals are pastured, is the urine saved to the soil, and this part of excreta contains the major part of the nitrogen.

The nitrogen in the manure is not by any means all available, at best not more than fifty per cent., and in many cases not even so much; owing to the careless in handling of the dung. On this basis the fertilizing value of the manure would be about 80 cents (three-fourths of the potash and phosphoric acid and one-fourth of the nitrogen); this added to the value as a food, $1.58, increases the net value to $2.38, and the difference (73 cents) between this sum and the fertilizing worth, is fully made up in the green-manurial value of the vegetable matter in the tops.

It is thus seen that theoretically, at least, the tops are of equal value in whichever way they are used; therefore it would be foolish for a man who did not own cows to buy them and burden himself with a new industry for the sake of using the beet tops economically. But for those who have animals a wise choice could be made by considering the general conditions of land, food, labor, etc., without regard to figures and values.

We must not forget in this connection that the sugar-beet tops *alone* will not constitute a balanced ration, or even approach it. They can only be used as a portion of the roughage food given to the animals.

On account of the bitter taste imparted to the milk by the beet tops, their use as a feed is not recommended in dairies supplying milk to be consumed as such.

It is claimed by some authorities that an excessive use of sugar-beet tops will prove injurious to the animals on account of the oxalic acid present; hence the conjoined use of lime in countries where the leaves are siloed.

Beet-Sugar Molasses.—In Europe a number of "molasses feeds"

have been proposed. One of these, which has been used to a considerable extent, is made up of bran four parts, molasses three parts, and palm-nut cake one part. Molasses is also mixed with dried blood, with peat*, and with beet pulp. The latter mixture is dried, and possesses good keeping qualities.

In a number of reported European experiments molasses feeds were tested with dairy cows. No deleterious results were noticed, even when four to five pounds of molasses was fed daily. An extended study of the value of molasses as part of a ration for pigs, steers, milch cows, and horses was recently reported in a French agricultural journal. The principal conclusions from the investigations were as follows: When molasses formed part of the ration of sheep, pigs, and steers, the gains in live weight were rapid. When molasses was fed to milch cows the total milk yield and the amount of fat and milk sugar in the milk were increased. The increase is not regarded as sufficient to warrant the conclusion that molasses is a suitable food for milch cows. Molasses is regarded as an excellent food for horses. It was rapidly eaten, and vigor and weight were maintained when it was added to the ration. It may be advantageously employed for rendering inferior hay or fodder more palatable.

As pointed out in the Canadian Experimental Farm Reports, one-half of the ash of beet-sugar molasses is potash. It is the presence of this, no doubt, that is the cause of the looseness of the bowels when fed above a certain quantity per diem. When symptoms of this condition are observed the quantity of molasses fed should be reduced. Since potash is not retained by the animal, but is eliminated by the kidneys, the urine will be especially rich in this element, and therefore should be carefully preserved by the use of absorbent bedding.

The reports of the Canadian Experimental Farm, already referred to, notes briefly the successful use of sugar-beet molasses in fattening steers. Three to five pounds was fed per day, diluted somewhat, and poured over the cut coarse fodder. It is said that the steers developed a great liking for it, and to all appearances it gave good results. The test was summed up as follows:

"The most important points in favor of this new feeding stuff may be stated as follows: (1) It contains a large percentage of sugar, the most assimilable form of carbohydrates found in cattle feed; (2) it stimulates the appetite, and (3) probably increases the digestibility of the other constituents of the ration."

Sugar-Beet Pulp.—In the process of manufacturing beet sugar there remains a by-product containing a large proportion of water and for which no profitable use has been found thus far, except as a food for stock. Upon the arrival of the sugar-beets at the factory they are first washed and then run through a slicing machine which shreds them into small strips resembling a large size of twine. The shredded beets are placed in large cylinders through which hot water is forced and the sugar thereby dissolved out of the beets. The portion remaining after the sugar has passed off in solution is what is known as beet-pulp, or residue. It is of no further use to the manu-

* When mixed with peat the digestibility is reduced, because the peat acts as so much dead weight.

facturer, who is always ready to dispose of it at a nominal price. Because of its passing through such a soaking process, the beet pulp comes from the factory with a high content of water, which in most cases is about ninety per cent. of its total weight. It is therefore heavy material to handle, and the cost of transportation is likely to be high in proportion to its actual value, either for food or any other purpose. The presence of so much water, however, renders the beet residue of much value for milch cows where other succulent foods, as green pasture, silage or soiling crops, are not available.

Several years of experience in California have proven sugar-beet pulp of value for fattening cattle as well as for producing milk, and the fact is that the larger portion of the beet pulp in the State is consumed by cattle which are being fitted for the butcher's block. It has been fed also to some extent to sheep. Both cattle and sheep eat the pulp so readily that there is scarcely any difficulty about getting them accustomed to it. So far as we are able to learn all those who have fed beet pulp to either of these kinds of stock have been successful except where they tried to make the pulp the sole food. This should never be done for more than a few days at most, because the animal cannot consume enough of such watery food to maintain life and produce milk or meat. Moreover, as a general principle, an animal should never be expected to do its best when confined to a single article of diet.

Storing Beet Pulp.—When a pile of beet pulp has been subjected to the weather for some time the whole exposed surface decays to a depth of six to eight inches, forming a crust which serves as a seal to preserve the under-lying material. Beet pulp may be said, therefore, to silo itself; and the chief points in arranging storage for it are to confine the desired quantity into as small a space as possible and reduce the exposed surface to a minimum. These points are secured by means of silos of various kinds. Since the food value of beet pulp is so small in proportion to its weight, there is no profit in constructing costly storage places; therefore the silo may be cheap, but it must be strongly built.

The silo shown in Figure 1 is used in connection with the beet-sugar factory and dairy in Alvarado. The large trestle carries the beet pulp from the factory, seen in the background, and drops it into the silo below. The silo is 460 feet long, 80 feet wide, and 8 feet deep. It is floored and sided with two-inch plank, and the sloping sides are supported by heavy posts set in the ground and braced with strong timbers. Three tracks run through the silo, one on each side and one in the center, on which a car is drawn by a horse to carry the pulp to the cattle barns several rods distant. A large amount of pulp may still be seen in the photograph of the silo, which was taken March 30, 1901.

Another silo built on the same principle is shown in Figure 2. This may be made of the roughest sort of lumber and of any size to suit the convenience of the feeder. The cut represents a silo twelve feet wide, thirty feet long and six feet deep, and which will hold about two carloads of pulp.

Figure 3 represents a simple and cheap way of constructing a silo by excavating a passage through, or in a hill. The bottoms should

FIG. 1.—Beet-pulp Silo; Alvarado Sugar Works.

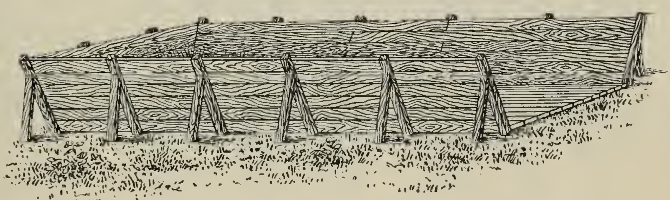

FIG. 2.

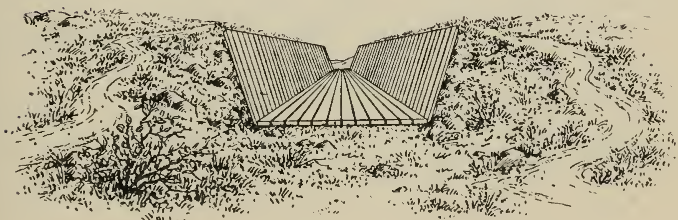

FIG. 3.

be planked in all such cases and means provided whereby the water draining from the pulp may be easily and quickly carried off. The planks should, therefore, set well up from the ground and be far enough apart to leave a crack between them after they have swelled with the contact with moisture from the pulp. The sides may or may not be planked, but less pulp is lost if they are covered with boards. This silo may also be made of any desired size. One used by Mr. John E. Koster is 600 feet long, 50 feet deep, 20 feet wide at the base and 80 feet wide at the top. The bottom only is planked, and has gutterways under the floor, so as to thoroughly drain the pulp. The silo is filled by means of carriers bringing the pulp directly from the sugar factory to the upper part of the silo when the carrier is dumped. In the small silo shown in the figure the filling can be done by driving the wagon alongside the top of the silo and shoveling the pulp into it. None of the silos for preserving beet pulp need any roof.

FEEDING STANDARDS.

Having ascertained the composition of the feeding-stuffs and their digestion-coefficients, the next step is to know just how much the animals require per day to keep them in a normal and healthy condition. These amounts are called *rations*. As might be supposed, this differs with the purpose for which the animal is kept, whether it is growing, being fattened, used for work, or making milk. A horse that is working hard all day in the plow certainly requires more food than one that is doing nothing at all; although, even in that case, the animal needs some of each of the nutrients in order to perform the functions of the body.

The standards commonly in use in this country are the ones set down by the German investigators in this subject, notably Dr. E. Wolff, by whom the following table has been worked out:

TABLE IV.—Feeding Standards.

Pounds per Day per 1,000 Pounds Live Weight.

	Total Dry Matter.	Nutrients.				Nutritive Ratio.
		Protein.	Carbo-Hydrates.	Fat.	Total.	
1. Horse at light work	21.0	1.5	9.5	.40	11.4	1:7
2. Horse at average work	22.5	1.8	11.2	.68	13.7	1:7
3. Horse at hard work	25.5	2.8	13.4	.80	17.0	1:5.5
4. Oxen at rest in stall	17.5	0.7	8.0	.10	8.8	1:4.9
5. Oxen fattening, 1st period	27.0	2.5	15.0	.50	18.0	1:6.5
6. Oxen fattening, 2nd period	26.0	3.0	14.8	.70	18.5	1:5.5
7. Oxen fattening, 3d period	25.0	2.7	14.8	.60	18.1	1:6.0
8. Milch cow	24.0	2.5	12.5	.40	15.4	1:5.4
9. Sheep, wool-producing, coarser breeds	20.0	1.2	10.3	.20	11.7	1:9.0
10. Sheep, wool-producing, finer breeds	22.5	1.5	11.4	.25	13.2	1:8.0
11. Sheep fattening, 1st period	26.0	3.0	15.2	.50	18.7	1:5.5
12. Sheep fattening, 2nd period	25.0	3.5	14.4	.60	18.5	1:4.5
13. Swine fattening, 1st period	36.0	5.0	27.5		32.5	1:5.5
14. Swine fattening, 2nd period	31.0	4.0	24.0		28.0	1:6.0
15. Swine fattening, 3d period	23.5	2.7	17.5		20.2	1:6.5
Growing Cattle. Age months. — Average live weight per head.						
2 to 3 — 150 lbs.	22.0	4.0	13.8	2.0	19.8	1:4.7
3 to 6 — 300 lbs.	23.4	3.2	13.5	1.0	17.7	1:5.0
6 to 12 — 500 lbs.	24.0	2.5	13.5	0.6	16 6	1:6.0
12 to 18 — 700 lbs.	24.0	2.0	13.0	0.4	15.4	1:7.0
18 to 24 — 850 lbs.	24.0	1.6	12.0	0.3	13.9	1:8.0
Growing Sheep.						
5 to 6 — 56 lbs.	28.0	3.2	15.6	0.8	19.6	1:5.5
6 to 8 — 66 lbs.	25.0	2.7	13.3	0.6	16.6	1:5.5
8 to 11 — 76 lbs.	23.0	2.1	11.4	0.5	14.0	1:6.0
11 to 15 — 82 lbs.	22.5	1.7	10.9	0.4	13.0	1:7.0
15 to 20 — 86 lbs.	22.0	1.4	10.4	0.3	12.1	1:8.0
Growing Pigs (Breeding Stock).						
2 to 3 — 50 lbs.	42.0	7.6	28.0	1.0	36.6	1:4.0
3 to 5 — 100 lbs.	34.0	5.0	23.1	0.8	28.9	1:5.0
5 to 6 — 124 lbs.	31.5	3.7	21.3	0.4	25.4	1:6.0
6 to 8 — 170 lbs.	27.0	2.8	18.7	0.3	21.8	1:7.0
8 to 12 — 250 lbs.	21.0	2.1	15.3	0.2	17.6	1:7.5
Growing Pigs (Fattening).						
2 to 3 — 50 lbs.	44.0	7.6	28.0	1.0	36.6	1:4.0
3 to 5 — 100 lbs.	35.0	5.0	23.1	0.8	28.9	1:5.0
5 to 6 — 150 lbs.	33.0	4.3	22.3	0.6	27.2	1:5.5
6 to 8 — 200 lbs.	30.0	3.6	20.5	0.4	24.5	1:6.0
9 to 12 — 300 lbs.	26.0	3.0	18.3	0.3	21.6	1:6.4

TABLE IV.—Feeding Standards. (*Continued.*)

Per Head per Day.

Age months.	Average live weight per head.	Total Dry Matter.	Nutrients. Protein.	Carbo-Hydrates.	Fat.	Total.	Nutritive Ratio.
Growing Cattle.							
2 to 3	150 lbs.	3.3	0.6	2.1	.30	3.0	1:4.7
3 to 6	300 lbs.	7.0	1.0	4.1	.30	5.4	1:5.0
6 to 12	500 lbs.	12.0	1.3	6.8	.30	8.4	1:6.0
12 to 18	700 lbs.	16.8	1.4	9.1	.28	10.8	1:7.0
18 to 24	850 lbs.	20.4	1.4	10.3	.26	11.0	1:8.0
Growing Sheep.							
5 to 6	56 lbs.	1.6	0.18	0.87	.05	1.10	1:5.5
6 to 8	60 lbs.	1.7	0.18	0.85	.04	1.07	1:5.5
8 to 11	76 lbs.	1.7	0.16	0.85	.04	1.05	1:6.0
11 to 15	82 lbs.	1.8	0.14	0.89	.03	1.06	1:7.0
15 to 20	86 lbs.	1.9	0.12	0.88	.03	1.03	1:8.0
Growing Pigs (Fattening).							
2 to 3	50 lbs.	2.1	0.38	1.50		1.88	1:4.0
3 to 5	100 lbs.	3.4	0.50	2.50		3.00	1:5.0
5 to 6	124 lbs.	3.9	0.54	2.96		3.50	1:5.5
6 to 8	170 lbs.	4.6	0.58	3.47		4.05	1:6.0
8 to 12	250 lbs.	5.2	0.62	4.05		4.67	1:6.5

Besides the necessary amount of nutrients, the food must have a certain bulk furnished by the coarse fodder, which helps digestion, and tends to keep the animal satisfied and healthy. The measure of the bulk is the amount of dry matter, or organic matter, in the ration, as shown by the figures 24 for the ration of a milch cow; of course, this may vary without any serious results. The kind of food a dairyman would give depends on what is the main crop or by-product in his section, how near he is to market, and the cost of the different concentrated foods at his command.

Grave errors may arise by following too closely the standards and rations set down by chemical research alone, without taking into account the local circumstances, and the individual needs of the animals, as well as the variation of the feeding-stuffs themselves; yet, without any knowledge of the composition of the substance fed, the farmer is not only in the dark as to the benefit to be derived from the food, but is also ignorant of the actual amount necessary; thus, at times, wasting considerable and valuable material.

RATIONS.

From the figures given in Table IV, rations can be calculated by having the analyses of the different foods before one. In order to facilitate matters in this direction, Table V has been made up from data given in Table II. It shows the total weight of dry matter, and amounts of digestible nutrients in different weights of feeding-stuffs. The use of this table is explained on page 31.

TABLE V.—Pounds of Dry Matter and Digestible Nutrients in Different Quantities of Fodders and Feedstuffs.

	Lbs.	Dry Matter.	Proteim.	Carbo-hydrates.	Fat.	Nutritive Ratio.
Green Fodders.						
Alfalfa	5	1.00	.19	.36	.03	1: 2.3
	10	2.00	.37	.73	.06	
Australian saltbush	5	1.18	.13	.46	.02	1: 3.9
	10	2.35	.25	.92	.03	
Barley	5	1.05	.10	.51	.02	1: 5.8
	10	2.10	.20	1.02	.04	
Corn	5	1.04	.05	.58	.02	1:12.5
	10	2.08	.10	1.16	.04	
Marsh ("Biston") grass	5	2.50	.13	1.22	.04	1:10.2
	10	5.00	.26	2.44	.09	
Oats	5	1.90	.13	.92	.05	1: 8.1
	10	3.80	.26	1.84	.10	
Peas and oats	5	.80	.09	.36	.01	1: 4.2
	10	1.60	.18	.72	.02	
Sorghum	5	1.03	.03	.61	.02	1:21.8
	10	2.06	.06	1.22	.04	
Silage.						
Barley	5	1.30	.09	.64	.04	1: 8.2
	10	2.60	.18	1.27	.09	
Clover, red	5	1.40	.10	.68	.05	1: 7.9
	10	2.80	.20	1.36	.10	
Corn	5	1.25	.06	.67	.03	1:11.7
	10	2.50	.13	1.35	.06	
Oat	5	1.40	.08	.74	.04	1:11.0
	10	2.80	.15	1.48	.09	
Orchard grass	5	1.15	.06	.53	.05	1:11.4
	10	2.30	.11	1.06	.10	
Roots, Beet pulp, etc.						
Beets, Mangels	5	.50	.06	.24	.005	1: 4.5
	10	1.00	.11	.47	.010	
Beets, Sugar	5	.80	.08	.60	.005	1: 7.6
	10	1.60	.16	1.20	.010	
Beet pulp, fresh	5	.50	.05	.37	.006	1: 8.2
	10	1.00	.09	.73	.011	
Beet pulp, silage	5	.56	.06	.39	.010	1: 6.8
	10	1.11	.12	.77	.020	
Pie melons	5	.47	.03	.17	.010	1: 5.4
	10	.95	.07	.33	.020	
Pumpkins	5	.50	.06	.20	.015	1: 4.0
	10	1.00	.12	.40	.030	
Hays.						
Alfalfa	5	4.45	.62	1.86	.08	1: 3.3
	6	5.34	.74	2.23	.09	
	7	6.23	.86	2.60	.11	
	8	7.12	.99	2.97	.12	
	9	8.01	1.11	3.34	.14	
	10	8.90	1.23	3.71	.16	
	13	11.57	1.60	4.83	.20	
	15	13.35	1.85	5.57	.24	
	18	16.02	2.22	6.68	.28	
Australian saltbush	5	4.65	.44	1.90	.06	
	6	5.58	.53	2.29	.07	
	7	6.51	.61	2.68	.08	
	8	7.44	.70	3.06	.10	

TABLE V.—Pounds of Dry Matter and Digestible Nutrients in Different Quantities of Fodders and Feedstuffs. (*Continued.*)

	Lbs.	Dry Matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive Ratio.
Australian saltbush	9	8.37	.79	3.44	.11	
(*Continued.*)	10	9.30	.88	3.82	.12	
	13	11.09	1.14	4.97	.16	
	15	13.95	1.32	5.72	.18	
	18	16.64	1.58	6.88	.22	
Barley	5	4.57	.29	2.16	.08	1: 8.1
	6	5.49	.35	2.59	.09	
	7	6.40	.40	3.02	.11	
	8	7.31	.46	3.45	.12	
	9	8.23	.52	3.88	.14	
	10	9.14	.58	4.31	.16	
	13	11.89	.75	5.60	.20	
	15	13.72	.86	6.47	.23	
	18	16.46	1.04	7.76	.28	
Bur clover.....................	5	4.50	.37	2.06	.09	1: 6.2
	6	5.39	.44	2.47	.11	
	7	6.29	.51	2.88	.12	
	8	7.19	.58	3.30	.14	
	9	8.09	.65	3.71	.16	
	10	8.99	.73	4.12	.18	
	13	11.69	.94	5.36	.23	
	15	13.49	1.09	6.18	.26	
	18	16.18	1.31	7.42	.32	
Clover, red	5	4.25	.34	1.78	.09	
	6	5.10	.41	2.15	.10	
	7	5.95	.48	2.51	.12	
	8	6.80	.54	2.86	.14	
	9	7.65	.61	3.22	.15	
	10	8.50	.68	3.58	.17	
	13	11.05	.88	4.65	.22	
	15	12.75	1.02	5.36	.26	
	18	15.30	1.22	6.44	.31	
Oat	5	4.50	.22	2.19	.07	1:10.5
	6	5.40	.27	2.62	.09	
	7	6.30	.31	3.06	.10	
	8	7.20	.36	3.50	.12	
	9	8.10	.40	3.94	.13	
	10	9.00	.45	4.37	.15	
	13	11.70	.58	5.69	.19	
	15	13.50	.67	6.56	.22	
	18	16.20	.80	7.87	.26	
Wheat...........................	5	4.56	.18	2.30	.05	1:13.2
	6	5.47	.21	2.76	.07	
	7	6.38	.25	3.22	.08	
	8	7.29	.29	3.68	.09	
	9	8.20	.32	4.14	.10	
	10	9.12	.36	4.61	.11	
	13	11.86	.47	5.99	.14	
	15	13.78	.54	6.91	.16	
	18	16.41	.64	8.30	.20	

TABLE V.—POUNDS OF DRY MATTER AND DIGESTIBLE NUTRIENTS IN DIFFERENT QUANTITIES OF FODDERS AND FEEDSTUFFS. (*Continued.*)

	Lbs.	Dry Matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive Ratio.
Mixed	5	4.62	.22	2.36	.08	1:11.5
	6	5.54	.26	2.84	.10	
	7	6.46	.31	3.31	.11	
	8	7.39	.35	3.78	.13	
	9	8.31	.39	4.25	.15	
	10	9.24	.44	4.73	.17	
	13	12.00	.58	6.15	.21	
	15	13.85	.660	7.09	.250	
	18	16.62	.790	8.51	.300	
Straw, average	1	.89	.008	.39	.006	1: 5.0
	2	1.78	.016	.77	.012	
	3	2.67	.024	1.16	.018	
	4	3.56	.032	1.55	.024	
	5	4.45	.040	1.94	.030	
	7	6.23	.056	2.71	.048	
	9	8.01	.072	3.48	.054	
Gourd Vines.						
"Mock Orange"	5	4.30	.26	1.88	.06	1: 7.9
	6	5.16	.31	2.25	.08	
	7	6.02	.36	2.63	.09	
	8	6.88	.41	3.00	.10	
	9	7.74	.46	3.38	.11	
	10	8.60	.51	3.75	.13	
	13	11.18	.67	4.88	.16	
	15	12.90	.77	5.63	.19	
	18	15.48	.92	6.75	.23	
Grain and Millstuffs.						
Barley, rolled	1	.90	.10	.63	.02	1: 7.1
	2	1.80	.19	1.27	.04	
	3	2.70	.29	1.90	.06	
	4	3.60	.38	2.54	.08	
	5	4.50	.48	3.17	.10	
	7	6.30	.58	4.44	.14	
Oats	1	.89	.09	.47	.04	1: 6.2
	2	1.68	.18	.95	.08	
	3	2.67	.28	1.42	.13	
	4	3.56	.37	1.89	.17	
	5	4.45	.46	2.36	.21	
	7	6.23	.64	3.31	.29	
Wheat, whole	1	.89	.09	.50	.01	1: 5.6
	2	1.77	.19	1.00	.03	
	3	2.66	.28	1.50	.04	
	4	3.54	.38	2.00	.06	
	5	4.43	.47	2.50	.07	
	7	6.27	.65	3.50	.09	
Wheat, screenings	1	.89	.08	.49	.02	1: 6.6
	2	1.78	.16	.97	.04	
	3	2.66	.24	1.46	.05	
	4	3.55	.32	1.95	.07	
	5	4.44	.40	2.44	.09	
	7	6.22	.56	3.41	.13	

TABLE V.—Pounds of Dry Matter and Digestible Nutrients in Different Quantities of Fodders and Feedstuffs. (*Continued.*)

	Lbs.	Dry Matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive Ratio.
Wheat, bran	1	.88	.11	.42	.03	1: 4.3
	2	1.76	.22	.84	.05	
	3	2.65	.34	1.27	.08	
	4	3.53	.45	1.69	.10	
	5	4.41	.56	2.11	.13	
	7	6.18	.79	2.95	.18	
Wheat, Middlings	1	.88	.12	.53	.04	1: 5.1
	2	1.76	.24	1.07	.08	
	3	2.65	.37	1.60	.11	
	4	3.53	.49	2.14	.15	
	5	4.41	.61	2.67	.19	
	7	6.18	.85	3.74	.27	
Wheat, Shorts	1	.90	.12	.48	.03	1: 4.5
	2	1.80	.24	.96	.06	
	3	2.70	.36	1.44	.09	
	4	3.60	.49	1.92	.11	
	5	4.50	.61	2.40	.14	
	7	6.30	.85	3.35	.20	
Mixed feed	1	.89	.10	.47	.03	1: 5.6
	2	1.79	.19	.95	.06	
	3	2.68	.29	1.42	.09	
	4	3.58	.38	1.90	.12	
	5	4.47	.48	2.37	.15	
	7	6.16	.67	2.84	.21	
Corn meal	1	.88	.06	.66	.03	1:11.6
	2	17.6	.13	1.33	.07	
	3	2.64	.19	1.99	.10	
	4	3.52	.26	2.65	.13	
	5	4.40	.32	3.31	.17	
	7	6.16	.45	4.64	.24	
Oil-Cake Meals.						
Linseed (new process)	½	.45	.13	.19	.03	1: 2.
	1	.89	.26	.38	.07	
	2	1.78	.52	.77	.13	
	3	2.67	.78	1.15	.20	
	4	3.56	1.04	1.54	.26	
	5	4.45	1.30	1.92	.33	
Cocoanut	½	.43	.08	.21	.05	
	1	.86	.16	.42	.10	
	2	1.72	.33	.85	.20	
	3	2.58	.49	1.27	.30	
	4	3.44	.66	1.70	.40	
	5	4.30	.82	2.12	.50	
Cottonseed	½	.45	.21	.08	.06	1: 1.
	1	.90	.41	.15	.11	
	2	1.80	.82	.31	.22	
	3	2.70	1.23	.46	.33	
	4	3.60	1.64	.62	.44	
	5	4.50	2.05	.77	.55	

FEEDING COWS AND STEERS.

The large and rapidly increasing dairy interests of this State render the feeding of milch cows a very important subject. No animal responds more gratefully or profitably to careful feeding, and there is none more willing to consume coarse foods than she. This is due to the peculiar construction of her digestive system, which, like that of other ruminants, includes four stomachs, three of which enable her to prepare for digestion and assimilation of nutriment from food entirely unsuited to non-ruminants. But because she can utilize this roughage does not mean that this kind of food is sufficient for her wants.

As Dr. Allen says: "The cow requires not only materials for her maintenance, but must also have protein, fat, and carbohydrates to make milk from. The milk contains water, fat, protein (casein or curd), sugar, and ash, and these are all made from the constituents of the food. If insufficient protein, fat, and carbohydrates are contained in the food given her, the cow supplies the deficiency for a time by drawing on her own body, and gradually shrinks in quantity and quality of milk, or both. The stingy feeder cheats himself as well as the cow. She suffers from hunger, although her belly is full of swale hay, but she also becomes poor and does not yield the milk and butter she should. Her milk glands are a wonderful machine, but they cannot make milk casein out of carbohydrates or coarse, unappetizing, indigestible swale hay or sawdust, any more than the farmer himself can make butter from skim milk. She must not only have a generous supply of good food, but it must contain a sufficient amount of the nutrients needed for making milk. Until this fact is understood and appreciated, successful, profitable dairying is out of the question. The cow must be regarded as a living machine. She takes the raw materials given her in the form of food, and works them over into milk. If the supply of proper materials is small, the output will be small. The cow that will not repay generous feeding should be disposed of at once, and one bought that will. There are certain inbred *characteristics* which even liberal feeding cannot overcome."

How to Use Tables in Compounding Rations.—Suppose a dairyman were feeding dairy cows and wished to make up a ration in accordance with standard 8, viz.: 24 pounds dry matter, 2.5 pounds digestible protein, 12.5 pounds digestible carbohydrates with .4 pounds of fat, from oat hay, bran, middlings, and linseed meal. A general principle, where grain is fed to cows, is to make up the ration in such a way as to have about two-thirds of the total dry matter supplied by the coarse fodder and the remaining one-third by the concentrated food. In this case, then, the dairyman would need about 18 pounds of hay, which by the table is found to contain 16.2 pounds of dry matter, or about two-thirds of 24, the total amount required by a 1000-pound cow. Eight pounds of dry matter is then left to be furnished by the grain, and

about nine pounds will be needed, since nearly all the grain contains approximately ninety per cent. of dry matter. For a continuous diet it is not well to feed more than two pounds daily per head of linseed meal, and it will therefore require this amount for the ration. We will suppose that the remaining seven pounds may be divided so as to use three pounds of bran and four pounds of middlings. Turning to Table V for the several quantities as above mentioned of the different foods, the following ration can be compounded:

Lbs.		Dry Matter.	Protein.	Carbohydrates.	Fat.
18	Oat hay	16.20	.80	7.87	.26
3	Bran	2.65	.34	1.27	.08
4	Middlings	3.53	.49	2.14	.15
2	Linseed meal	1.78	.52	.77	.13
		24.16	2.15	11.95	.62

Nutritive ratio, 1: 6.25.

The ration is lacking mainly in protein, which makes the nutritive ratio wider than is called for by the standard. The total amount of dry matter is high enough, and thus any change cannot be made by adding other foods, but must be made by substituting some food containing a large percentage of protein for one of the foods now used. Cottonseed meal may be used for this substitution, and one pound will suffice in place of one pound of middlings. The altered ration would then be:

Lbs.		Dry Matter.	Protein.	Carbohydrates.	Fat.
18	Oat hay	16.20	.80	7.87	.26
3	Bran	2.65	.34	1.27	.08
3	Middlings	2.65	.37	1.60	.11
2	Linseed meal	1.78	.52	.77	.13
1	Cottonseed meal	.90	.41	.15	.11
		24.18	2.44	11.66	.69

Nutritive ratio, 1: 5.4.

This ration corresponds very closely to the standard, and would undoubtedly give better results than the first one. The pound of cottonseed meal costs much more than one pound of middlings, but, considering the amount of protein furnished, the cottonseed meal is the cheaper.

As another illustration; a dairyman writes that he is feeding 9 pounds of alfalfa hay, 50 pounds of corn silage and 5 pounds of wheat bran. Taking the sum of the various nutrients from Table V as before, we find the ration to contain the following:

Lbs.		Dry Matter.	Protein.	Carbohydrates.	Fat.
9	Alfalfa hay	8.01	1.11	3.34	.14
50	Corn silage	12.50	.64	6.74	.28
5	Wheat bran	4.41	.56	2.11	.13
		24.92	2.31	12.19	.55

Nutritive ratio, 1:5.8. Cost, 100 cows per day, $12.85.

With the exception of a shortage in protein, this is a very good ration. It may be benefited in this respect by feeding less silage and more bran, when a ration somewhat as follows is the result:

Lbs.		Dry Matter.	Protein.	Carbohydrates.	Fat.
9	Alfalfa hay	8.01	1.11	3.34	.14
35	Corn silage	8.75	.44	4.72	.20
9	Wheat bran	7.95	1.02	3.81	.24
		24.71	2.57	11.87	.58

Nutritive ratio, 1:5.1. Cost, 100 cows per day, $14.75.

This ration is better than the original one from the standpoint of the protein and nutritive ratio. It also has the proportion of one-third of the total dry matter made up of concentrated foods as mentioned in the first illustration. But it is more expensive than the original by nearly two dollars per day for 100 cows. The principle referred to, in regard to making two-thirds of the dry matter of the ration come from the coarse fodder and one-third from the concentrates, is an Eastern feeding practice. It is partly necessary because the concentrates must be used to supply the requisite amount of protein, since most of the Eastern coarse fodders do not contain this element in so large a proportion as alfalfa. With alfalfa, as shown elsewhere, it is possible to provide enough protein without using any other food. Taking the three foods in question, we may make another ration, depending more largely upon the alfalfa for protein, as follows:

Lbs.		Dry Matter.	Protein.	Carbohydrates.	Fat.
12	Alfalfa hay	10.68	1.48	4.46	.18
40	Corn silage	10.00	.50	5.39	.22
4	Wheat bran	3.53	.45	1.69	.10
		24.21	2.43	11.54	.50

Nutritive ratio, 1:5.2. Cost, 100 cows, per day, $12.20.

This is the cheapest of all three rations, and is as good as the second as regards the total and proportion of digestible nutrients. It contains less bran than either of the others, but is sufficient to make a good palatable ration. The calculation of the cost of the ration is based on prices as given in Table III on page 14.

Additional matter relating to the feeding of milch cows is given in the body of this Bulletin.

Feeding Alfalfa.—Bulletin No. 148 of the New Jersey Experiment Station reports experiment an comparing alfalfa protein with purchased protein for dairy cows. They fed four cows during a period of two months on two separate rations, one made up of corn silage, alfalfa hay, mixed hay, and cotton-seed meal; the other of corn silage, mixed hay, wheat bran, dried brewer's grains, and cotton-seed meal. The results of the experiment are summarized in the table showing the food consumed, the yield of milk and butter per head daily, and the cost for food to produce 100 pounds of milk and 1 pound of butter with each ration.

		Food consumed per cow per day.							Yield.		Cost to produce.	
	No. of days.	Corn silage.	Alfalfa hay.	Mixed hay.	Wheat bran.	Dried brewers' grains.	Cottonseed meal.	Cost of ration. Cents.	Milk, pounds.	Butter, pounds.	100 pounds milk. cents.	1 pound butter, cents.
Ration 1..	60	35	11	6	....	....	2	12.08	20.8	.87	58.0	12.0
Ration 2..	60	35	....	6	4	4	2	15.38	21.8	.92	70.7	14.3

This experiment shows that while the ration in which the protein was supplied by purchased grain produced slightly more milk and butter than the alfalfa ration, still the latter produced milk at 12.7 cents per 100 pounds and butter at 2.3 cents less per pound than the former. It will be noticed that two pounds of cotton-seed meal were in each ration, and that there was no comparison of rations wholly without grain.

The usual feeding practice in alfalfa districts is to depend entirely upon alfalfa pasture and alfalfa hay for cattle feed, except for the vexing foxtail, which comes up every spring. That this is a cheap method of feeding cannot be denied. That it would be cheaper to supplement the alfalfa with other feeds, either grown at home or purchased, is not yet proven to the satisfaction of all. The experience of a few dairymen has shown that some straw judiciously fed with alfalfa has lessened the cost of the ration and added to its palatability. The few also who have fed corn silage report most satisfactory results. The most simple rule of animal feeding is broken when a cow is required to subsist on alfalfa alone, or any other single food, for no animal can be expected to do its *best* when confined to a single food. The question then comes, will the cow do so much better on two or three different foods to pay for buying or raising the extra ones? On many ranches food material goes to waste, or is burned; such as straw, which if well preserved would be relished by the cow along with alfalfa. And in every dairy section in California corn can be grown in sufficient quantity to furnish silage to supplement dry pasture and add to the cow's change of food.

A few illustrative rations will show how the cost of feeding varies between feeding much or little grain, or little or much alfalfa. In calculating the cost of the following rations the same schedule of prices is used as shown in Table III. The rations are each made up with a view to secure as nearly a standard ration as possible with the foods used, and to have them all nearly the same in total dry matter. The various rations follow:—

RATION 1

10 lbs alfalfa hay
8 lbs barley hay
3 lbs wheat bran
3 lbs crushed barley
2 lbs corn meal
Nutritive ratio, 1:5.2
Cost 100 cows per day $15.30

RATION 2

13 lbs alfalfa hay
10 lbs barley hay
2 lbs wheat bran
2 lbs crushed barley
Nutritive ratio 1:5
Cost 100 cows per day $13.10

RATION 3

13 lbs alfalfa hay
13 lbs barley hay
Nutritive ratio 1:4.8
Cost 100 cows per day $11.05

RATION 4

20 lbs alfalfa hay
8 lbs straw (average)
Nutritive ratio 1:4.5
Cost 100 cows per day $9.20

RATION 5

27 lbs alfalfa hay
Nutritive ratio 1:3.3
Cost 100 cows per day $10.80

Feeding Beet Pulp.—We have no detailed experiment to report for this State concerning the value of beet pulp as a stock food, nor showing

how it should best be fed. We have, however, the record of milk production from a small herd of cows which were fed beet pulp for about ten weeks. And through the kindness of several of the leading stockmen of the State we have secured their experience in feeding it and are able to present it here. It is interesting to note that the results obtained from feeding the pulp in this State agree with European experience.

The herd of cows mentioned above were owned in Berkeley by Mr. W. B. Barber, who kept the milk record and weighed the beet pulp which each cow consumed. The cows were mostly Shorthorn foundation, with some infusion of Jersey blood. All but "Jersey" dropped their calves in July, 1900, and she in April. Owing to various circumstances, it was not possible to keep an accurate record of the weight of hay consumed, and thus the amount required by each cow can be given only approximately. When no beet pulp was fed, the cows ate an average of about 20 pounds of hay per head daily in addition to 8 pounds of grain. When eating beet pulp the daily consumption of hay varied from 6 to 16 pounds, depending upon the amount of beet pulp in the ration and the size of the cow. The hay was a fair quality of oat with a slight ad-mixture of bur clover. The grain consisted of 8 pounds per head daily of a mixture of 3 parts of wheat bran and 2 parts of cocoanut-cake meal given dry in two feeds. Calculating this ration on a basis of 8 pounds of grain, 9 pounds of hay, and 60 pounds of beet pulp, it had a nutritive ratio of 1:6.2 and contained 21.75 pounds of dry matter.

The sugar-beet pulp was donated to the Station by the Alameda Sugar Company of Alvarado, through the kindness of the superintendent of the company, Mr. E. W. Burr. Transportation was furnished to Berkeley free on the first car-load of pulp, and at half rates on the second car-load by the Southern Pacific Railroad Company.

The record of milk production, as given in the table below, began on September 5, 1900. From that date until October 10th the feed of the cows was hay and grain, as mentioned above. On the latter date, which was the sixth week in the table, beet pulp was given to all the cows in small quantities. This amount was so irregular, owing to the freshness of the pulp and the dislike of most of the cows for it in that condition, that a full ration of pulp was not secured until the seventh week. For the succeeding three weeks hay was fed once a day and beet pulp once, in amounts varying from 40 to 65 pounds per head, according to the size and appetite of the animal. Beginning with the tenth week, the hay, grain, and beet pulp were fed together, each in two daily feeds. With some of the cows the quantity of pulp given was increased 5 pounds per day until they received 80 pounds each, and with others decreased until they received only 20 pounds each. After a time the order was reversed; the rations for those receiving the large amounts were decreased, and for those receiving small amounts increased until two were receiving 90 pounds each daily. The period of feeding beet pulp closed during the sixteenth week, after which the cows received the former ration of hay and grain. During the whole period the cows had the range of several small fields, but the amount of food obtained there was of little practical value.

The beet pulp seemed to impart no foreign or disagreeable flavor to the milk. The milk was delivered daily to customers in Berkeley, and no complaint was made as to its quality. The effect of the pulp upon the flow of milk was on the whole beneficial. Most of the cows were decreasing in yield up to the time when we began to feed beet pulp, after which all increased in quantity, and continued to hold out well until the beet pulp was exhausted, when there was a noticeable decrease. In regard to the influence of beet pulp upon the percentage of fat in the milk, the records do not show any material effect either in raising or lowering the proportion of fat. The record of milk and fat production is given below, for the study of all who are interested therein.

The milk record was kept as follows:—Each cow's milk was weighed at every milking as soon as drawn, and the weight recorded on a sheet provided for the purpose. At the same time about one-half ounce of the milk was taken as a sample to test for fat, and placed in a bottle containing milk preservative. These composite samples were tested for fat once a week by the Babcock test. In the record, then, we have the weight of milk for each week, the average weekly per cent. of fat, and the pounds of fat produced each week. This record is given in the table below, together with the quantity of beet pulp consumed by each cow per week.

TABLE VI.—Individual Weekly Record of Milk and Fat Produced and of Beet Pulp Consumed.

	NORMAN. Jersey—Shorthorn. Age 6 years.				LINE BACK. Aryshire—Shorthorn. Age 5 years.			
No. of Weeks.	Milk, Pounds.	Fat, Per cent.	Fat, Pounds.	Beet Pulp Pounds.	Milk, Pounds.	Fat, Per cent.	Fat, Pounds.	Beet Pulp Pounds.
1	156.3	4.5	7.03	....	174.9	3.4	5.95	....
2	148.2	4.2	6.22	....	183.4	3.3	6.05	....
3	154.8	3.8	5.88	....	185.4	3.5	6.49	....
4	148.1	4.2	6.22	....	182.3	3.4	6.30	....
5	138.8	4.4	6.11	....	172.1	3.6	6.20	....
6	139.9	4.6	6.44	....	165.5	3.6	5.96	....
7	154.4	4.4	6.79	365	171.7	4.2	7.21	355
8	158.4	4.4	6.97	385	169.6	3.6	6.11	455
9	142.9	4.4	6.29	385	174.7	3.7	6.46	435
10	138.2	4.1	5.67	485	185.1	3.7	6.85	545
11	128.6	4.2	5.40	560	189.1	3.8	7.19	560
12	144.6	5.0	7.23	555	170.2	4.1	6.98	555
13	147.2	4.8	7.07	385	183.4	3.9	7.15	385
14	137.1	4.6	6.31	170	163.5	3.8	6.21	170
15	141.1	4.5	6.35	140	175.0	3.7	6.48	140
16	127.9	4.5	5.76	40	173.8	3.8	6.60	40
17	123.5	5.0	6.18	....	166.1	4.1	6.81	....
18	122.9	5.2	6.39	....	167.9	4.1	6.88	....
19	121.1	5.2	6.30	....	156.3	4.1	6.41	....

TABLE VI.—Individual Weekly Record of Milk and Fat Produced and of Beet Pulp Consumed. (*Continued.*)

	STRUBE. Jersey—Shorthorn. Age 6 years.				JERSEY. High Grade Jersey. Age 10 years.			
No. of Weeks.	Milk, Pounds.	Fat, Per cent.	Fat, Pounds.	Beet Pulp Pounds.	Milk, Pounds.	Fat, Per cent.	Fat, Pounds.	Beet Pulp Pounds.
1	176.5	3.7	6.63	......	121.1	6.0	7.27	......
2	177.4	3.6	6.39	......	120.7	5.6	6.76	......
3	175.7	3.4	5.97	......	125.8	5.1	6.42	......
4	162.0	4.2	6.80	......	119.6	5.6	6.70	......
5	144.4	3.8	5.49	......	118.9	5.6	6.66	......
6	131.1	4.3	5.64	......	123.4	5.6	6.91	......
7	141.7	3.9	5.53	295	129.1	5.8	7.49	380
8	140.0	4.0	5.60	325	108.7	6.0	6.52	350
9	144.9	3.9	5.65	335	114.6	5.5	6.30	420
10	140.4	3.4	4.77	485	110.2	5.5	6.06	530
11	156.3	4.1	6.41	560	117.1	5.5	6.44	560
12	145.4	4.1	5.96	555	109.2	4.8	5.24	555
13	142.4	4.1	6.84	385	104.0	5.2	5.41	385
14	125.9	4.6	5.79	170	98.6	5.6	5.52	170
15	128.9	4.1	5.28	140	105.2	5.5	5.79	140
16	129.9	3.9	5.07	40	89.9	5.8	5.21	40
17	123.2	4.3	5.30	......	90.9	6.0	5.45	......
18	117.0	4.3	5.03	......	89.9	6.5	5.84	......
19	111.9	4.1	4.59	......	84.6	6.4	5.41	......

TABLE VI.—Individual Weekly Record of Milk and Fat Produced and of Beet Pulp Consumed. (*Continued.*)

	IRENE. Grade Shorthorn. Age 6 years.				SARAH. Grade Shorthorn. Age 6 years.			
No. of Weeks.	Milk, Pounds.	Fat, Per cent.	Fat, Pounds.	Beet Pulp Pounds.	Milk, Pounds.	Fat, Per cent.	Fat, Pounds.	Beet Pulp Pounds.
1	186.0	3.6	6.70	......	149.6	3.6	5.39	......
2	175.0	3.4	5.95	......	147.0	3.5	5.15	......
3	167.0	3.6	6.01	......	145.5	3.2	5.66	......
4	172.4	4.0	6.80	......	130.6	3.6	4.70	......
5	166.8	3.2	5.34	......	*99.3	3.6	3.57	.....
6	156.4	4.0	6.26	......	115.4	3.8	4.38	......
7	180.8	3.6	6.51	295	125.5	3.8	4.77	200
8	176.6	3.7	6.53	315	125.4	4.2	5.27	350
9	186.2	3.6	6.70	340	130.0	3.6	4.68	350
10	167.2	3.1	5.18	215	110.0	3.5	3.85	215
11	163.0	3.7	6.03	140	114.9	4.1	4.70	140
12	163.4	3.4	5.56	145	112.6	3.7	4.17	145
13	177.2	3.6	6.38	315	119.9	3.6	4.32	315
14	186.0	3.6	6.70	530	132.6	3.8	5.04	530
15	194.4	3.4	6.61	560	141.4	3.4	4.81	560
16	175.9	3.6	6.33	160	119.5	3.7	4.42	160
17	153.7	3.8	5.84	......	104.7	4.0	4.19	......
18	156.3	3.7	5.78	......	107.0	4.1	4.39	.....
19	144.6	3.8	5.49	....	98.5	4.2	4.14	......

* Sick.

TABLE VI.—INDIVIDUAL WEEKLY RECORD OF MILK AND FAT PRODUCED AND OF BEET PULP CONSUMED. (*Continued.*)

	KEOHAN. Grade Shorthorn. Age 8 years.				GEORGIA. Grade Shorthorn. Age 6 years.			
No. of Weeks.	Milk, Pounds.	Fat, Per cent.	Fat, Pounds.	Beet Pulp Pounds.	Milk, Pounds.	Fat, Per cent.	Fat, Pounds.	Beet Pulp Pounds.
1	127.4	4.4	5.60	......	165.6	3.6	5.96	......
2	112.8	4.6	5.19	......	169.4	3.8	6.44	......
3	121.3	3.6	4.37	......	168.0	3.6	6.05	......
4	102.0	4.2	4.28	......	152.5	3.7	5.64	......
5	103.8	4.5	4.67	......	147.9	3.2	4.73	......
6	107.7	4.7	5.06	.....	145.3	4.0	5.81	......
7	115.0	4.3	4.95	385	164.0	3.8	6.23	390
8	110.6	4.4	4.87	425	163.0	3.9	6.36	455
9	115.3	4.4	5.07	420	172.6	3.8	6.56	440
10	112.3	3.9	4.38	280	150.2	3.9	5.86	230
11	101.8	4.5	4.58	140	143.3	4.1	5.88	140
12	95.6	4.5	4.30	145	140.4	4.4	6.18	145
13	96.3	4.6	4.43	315	141.1	4.4	6.21	315
14	111.4	3.9	4.34	550	162.6	4.1	6.67	550
15	109.1	3.7	4.04	630	173.9	3.7	6.43	630
16	95.3	3.9	3.72	180	144.7	3.7	5.35	180
17	80.7	4.8	3.87	......	120.1	4.0	4.80	......
18	80.9	5.0	4.05	......	127.0	4.2	5.33	......
19	81.3	4.8	3.90	.....	124.3	4.2	5.22	.....

California Experience in Feeding Beet-pulp.—During the past year we submitted several questions to some of the leading stockmen of this State with a view to gathering their experience in feeding sugar-beet pulp. The parties who have replied are: Messrs. Henry Miller, John L. Koster, John H. Wise, W. Mayo Newhall, all of San Francisco; Thomas H. Silsbee, Point Conception; Fred D. Wiegman, Alvarado, and Messrs. Vail and Gates, Los Angeles. The questions asked and the answers of the different parties are here quoted.

Feeding Beef Cattle. 1.—How much pulp do you feed daily per head?

Mr. Koster.—90 to 100 pounds.

Mr. Wiegman.—About 100 pounds.

Mr. Silsbee.—An average of 112 pounds of siloed pulp.

Messrs. Vail and Gates.—A four-year old steer will eat about 80 pounds of siloed pulp.

Mr. Miller.—About 100 pounds of fresh or 60 pounds of fermented pulp.

Mr. Newhall.—The daily average consumed per animal will vary from 80 to 100 pounds. For animals of 1,000 to 1,100 pounds weight the former quantity should suffice.

2.—Do you feed hay or grain with the pulp, and if so, how much and of what kind?

Mr. Koster.—10 to 15 pounds uncut hay and 2½ to 5 pounds finely rolled barley—quantity regulated bv condition of the cattle and the

state of the weather. In cold weather a greater proportion of hay and barley than in warm weather.

Mr. Wiegman.—About 5 pounds of oat hay and 3 pounds of mixed "chop" feed.

Mr. Silsbee.—10 to 12 pounds of lima bean-straw.

Messrs. Vail and Gates.—About six pounds of barley hay and straw. Have generally fed about 8 pounds of ground corn for the last forty days of feeding. When we feed cotton-seed meal we give about 3 pounds per day.

Mr. Miller.—About ten pounds of either alfalfa hay, grain hay or straw chopped and mixed with grain, usually ground barley, though sometimes cracked wheat. The quantity of grain varies with the quality of the hay or straw. The better the hay the less grain used.

Mr. Newhall.—We fed rolled barley and chevalier barley-straw. The best result is obtained when the grain is crushed as finely as possible, the finer the better. Mill sweepings of grains, flour, corn, etc., are excellent. At the commencement of feeding the cattle a half pound of grain per day should be used and a full ration would be 8 to 10 pounds daily. We were from necessity forced to use chevalier barley-straw as a roughage, and from that experience, together with observation in the use of hay by others, I am decidedly of the opinion that such straw is far better; in fact, at the same price I would prefer the straw. In this connection I would beg to say that baled straw would have a market value of say $3.00 per ton, as against a value for baled hay of about $10.00 per ton.

3.—How long is the period during which you feed beet pulp continuously?

Mr. Koster.—During the winter months, covering a period of 90 to 120 days.

Mr. Wiegman.—Until fat; usually four to four and a half months.

Mr. Silsbee.—90 days.

Messrs. Vale and Gates.—From 100 to 120 days.

Mr. Miller.—About four months.

Mr. Newhall.—We fed during the season of 1900, 8000 head of beef cattle covering a period of about four months; but the average time in which various lots were finished and sold was about two months. The usual period in this State of those who have fed is from three to four months, but this would depend upon and materially vary according to the temperment and to the condition of the animal at the commencement of the feeding period.

4.—What is the effect of beet pulp in the production of meat?

Mr. Koster.—On good thrifty beef cattle the production of meat was superior to that of northern alfalfa-fed cattle. The meat was of fine flavor, good color, marbleized, and killing very white as to fat.

Mr. Wiegman.—Makes white fat and tender and juicy meat.

Mr. Silsbee.—Horned cattle gained an average of 1½ pounds per day, and dehorned cattle about two pounds per day.

Messrs. Vail and Gates.—Fattens rapidly after the first 30 days' feed. Makes a fine quality of beef, the tallow being very white.

Mr. Miller.—Has been more remunerative as a food for meat than for milk.

Mr. Newhall.—Pulp fed with grain and hay or straw, produces a very well marbled condition of the meat; a decided effect of the pulp is the fine white color given to the carcass when dressed. I am of the opinion that, coupled with the result of confinement, the muscles and sinews of the animals are softened and less in evidence upon the block, thus making a much more acceptable article of meat for sale and use.

5.—How much per ton do you consider you can afford to pay for pulp delivered at your ranch?

Mr. Koster.—This would depend upon the value of other food materials.

Mr. Wiegman.—One dollar per ton.

Mr. Silsbee.—Depends on the scarcity of cattle feed and the price of beef.

Messrs. Vail and Gates.—After being siloed and well drained, 75 cents per ton. Have never fed at ranch; have always shipped cattle to factory.

Mr. Miller.—It depends upon the price of beef. At present prices we can afford to pay 50 cents per ton for fresh and 75 cents per ton for fermented pulp.

Mr. Newhall.—It would be difficult to economically feed pulp away from the factory, as transportation and handling of pulp is quite expensive. Factories sell pulp at from 10 to 25 cents per ton; the former price has been the custom when taken away from the factory, the latter when conveniences and facilities for feeding cattle have been furnished at or near the factories. I doubt any profitable use for beef-feeding at over 25 cents per ton for pulp. At this price, and the usual value of grain and hay or straw, it will cost from $9.00 to $12.00 per head to put the animal into good marketable condition. At the present and usual price of purchase and sale of cattle in California these figures ($9.00 to $12.00) are the full margin of profit when fattened on grass on the ranges and without any extra cost of feeding. I am of the opinion that under ordinary conditions in our State, except by small farmers, pulp, or in fact any feeding, cannot be profitably carried on; but pulp is a most excellent thing to have in this State to fall back on in case of emergencies, like dry years and seasons when cattle do not properly fatten on the ranges. I believe, however, that small farmers who do their own work can purchase cattle, fatten them, and sell to a profit that would be satisfactory to them, especially as lots can be turned off every three or four months. This would be especially true of farmers in the localities where sugar beets are raised, and a long start made by feeding beet tops, and which would require but litle time, say one month, for finishing on pulp with grain and hay.

Feeding Dairy Cattle.—Mr. Koster and Mr. Wiegman are the only ones reporting any extensive practice of feeding beet pulp for milk. Mr. Koster writes that he considers 20 to 25 pounds per head daily a sufficient amount of pulp for a dairy cow. With the pulp he feeds from 25 to 30 pounds of uncut hay and five pounds of middlings per day. He says there was no noticeable odor in the milk when feeding pulp, but that "too much pulp had the tendency to lessen the yield of milk as well as to impoverish it."

Mr. Wiegman replies that he considers 80 pounds of pulp per head daily a maximum amount to be fed with profit, and 20 to 25 pounds as a minimum. His usual feed is about 80 pounds per day. With the pulp he feeds 6 to 7 pounds of hay (oat preferred) and 6 pounds of mixed "chop" feed. He has pulp continually and feeds it throughout the year. If the cows are fed wholly on pulp the milk seems to become poorer. No foreign odor or flavor is noticeable in the milk, except occasionally when the beet-pulp is fresh, none at all when feeding siloed pulp.

Feeding Other Stock.—Mr. Koster reports having fed beet pulp to sheep with good success, and adds: "In feeding pulp much depends upon the age and condition of the pulp, and upon the condition of the stock and suitable grounds for feeding."

Mr. Miller reports that they have fed pulp to sheep with satisfactory results, but do not consider it suitable to other animals than cattle.

Mr. Wise fed beet pulp to sheep only. He says: "Our experience was not very favorable. I am perfectly satisfied that beet-pulp alone will not fatten stock of any kind. We had to buy other food to mix with it, otherwise our sheep would have fallen off instead of gaining flesh."

Additional Comments.—The experience given above shows clearly that beet-pulp should not be depended upon as the sole diet either for producing milk or meat, the chief reason being that it does not adequately nourish the animal. When fed in connection with other and dry feed it not only serves to keep the digestion in a healthful condition, but adds materially to the store of actual food substance. The amount of pulp which can be fed profitably is reported by all who feed for meat, as all the animals will readily consume in addition to the portion of hay or straw and grain, as already mentioned. In the case of the profitable quantity to feed for milk production there seems to be a wide difference of opinion. It may be that 25 or 30 pounds per day of pulp will induce as large a flow of milk as 80 pounds per day when the rest of the feed is dry; the notion being that the lesser quantity gives the cow all the succulent food and change of diet which she really requires for the best production. Where the pulp must be hauled a long distance and the cost of transportation is therefore great, it would undoubtedly be unwise to feed it in larger amounts than would give the necessary succulence to the ration, and 25 pounds is probably sufficient for this purpose. But where the dairy is situated adjacent to the sugar factory, as at Alvarado, it might pay to feed the pulp in much larger quantities.

Some further notes in regard to feeding beef cattle are worthy of consideration. Mr. Newhall writes: "I would further assume to say that, in my opinion, the climate of our State is not the most suitable for feeding purposes, especially in winter. I would particularly direct caution in undertaking to feed cattle during our winter months in small enclosures, where mud, exposure to dampness and winds have had a decidedly detrimental effect." In this connection Mr. Koster says: "When cattle are once started on pulp feed, particularly when fed to be fattened foı beef, it is advisable to continue them at that until fully fat and then to slaughter them. If cattle have been

on this feed for a season, it is highly inadvisable, if they have reached the desired stage, to take them on green pasture, as this affects them seriously. Proper feeding grounds should be selected where the cattle can be sheltered during stormy weather."

List of Beet Sugar Factories in California.

1.	Alameda Sugar Company	Alvarado
2.	American Beet Sugar Company	Oxnard
3.	California and Hawaiian Sugar Refining Company	Crockett
4.	Chino Valley Beet Sugar Company	Chino
5.	Los Alamitos Sugar Company	Los Alamitos
6.	Spreckels Sugar Company	Spreckels
7.	Union Sugar Company	Santa Maria
8.	Western Beet Sugar Company	Watsonville

CALF FEEDING.

The proper growth and development of the calf is equally as important as the care of the full-grown cow, for good cows cannot be made out of poorly fed calves. Whether the calf be destined for the dairy or for the shambles, the true principle is to keep it in a thrifty growing condition until the end is reached. It is not necessary that the calf be fat—in fact, it is better not to be so. The feed should be such as to produce bone and muscle to form a strong framework with which to produce milk or upon which to lay fat in the time of maturity. The mother's milk, if it be not too rich in fat, furnishes the best food for the purpose, but in our commercial dairying butter fat can be disposed of at a higher price if made into cheese or butter and a substitute offered which is cheaper.

If the calf is to be raised on skim milk as the principal food, it should receive fresh whole milk for the first ten days or two weeks. Then substitute skim for whole milk, a little at first and increase gradually until, by the time the calf is three weeks old, it may receive no whole milk whatever. As soon as this substitution begins add a small handful of wheat middlings to the ration and increase the quantity gradually as the skim milk is increased. Induce the calf to eat dry grain and hay as soon as possible, and give the milk simply as a drink. It will be remembered that skim milk is highly nitrogenous, and to make it a perfect food requires the addition of carbonaceous material. Nothing supplies this any better than corn meal, but, owing to its high price, rolled barley may be used, mixing barley, wheat, bran, and middlings in equal parts and feeding from one to two quarts per day by the time the calf is two months old.

In the case of feeding whey one may begin when the calf is about two weeks old by adding a little to the regular ration of whole milk and increasing the portion, as suggested above with skim milk, until the calf is a month old, when the milk may be taken away entirely. Unlike skim milk, whey is more largely carbonaceous, owing to the removal of the casein as well as the butter fat. Thus the grain ration should contain more protein than for skim-milk feeding, and for this reason some linseed oil-cake meal should be added to the middlings as

soon as the whey is fed. Whenever the calf can be induced to eat the grain dry, give a mixture of two parts each of bran and middlings and one part of linseed meal. The calf developes a stronger digestion if it can be early induced to eat hay and its grain dry, and drink the milk or whey alone. The chief difficulties in feeding whey arise from permitting it to sour before feeding and depending upon it as the sole food. While it may be possible to raise fairly good calves on skim milk alone, it should never be attempted with whey, because the latter contains only about two-thirds as much food substance as the former. Both should always be fed sweet. The amount of grain necessary depends upon the quality of hay or pasture to which the calf has access. The hay should preferably be alfalfa.

HORSE FEEDING.

In making up rations for horses we must remember that the digestive organs of this animal differ materially from those of the cow, the former having but one stomach while the latter has four, three of which are used, in the main, to prepare the food for the fourth or true stomach, which corresponds to that of the horse. For this reason horses cannot assimilate as much from a bulky or coarse ration as is noted for the ruminants. Consequently when a horse is being heavily worked intelligent care must be given to the feeding. For instance, from thirty-five to forty-five pounds of silage can be fed daily to the cow, but less than one-third of that amount should constitute the daily portion for the horse.

When feeding cows it is generally considered best to have the grain or concentrated part of the ration form about one-third of the total dry matter, whereas, in the case of feeding horses, heavily worked, the proportion of grain may exceed one-half the total amount of food. One reason for using so much grain is in order to be sure that we have in the ration a generous amount of protein, so essential to the successful feeding of the horse.

In alfalfa sections so much protein can be supplied in green and cured alfalfa that much less grain is required than is necessary when the roughage consists of cereal hays only.

The following balanced rations for animals weighing 1,000 pounds illustrate this point:

	1.		2.		3.		4.
Lbs.	Material.	Lbs.	Material.	Lbs.	Material.	Lbs.	Material.
12	Alfalfa hay	15	Alfalfa hay	9	Alfalfa hay	10	Alfalfa hay
11	Wheat "	9	Wheat "	12.5	Barley "	12	Barley "
7	Crushed Barley	6	Cracked corn	7	Crushed Barley	7	Cracked corn
Nutritive ratio,	1:5.7		1:5.6		1:5.6		1:5.9

For a horse at light work 12.5 pounds of alfalfa hay with the same amount of cut straw forms a balanced ration. It may be mentioned that it is more economical, and also better for the digestion, to cut all the roughage.

If barley hay, rolled barley and cottonseed meal were the feeds in question, the ration would consist of 15 pounds barley hay, 12 pounds

crushed barley, and 1 pound cottonseed oil-cake meal. This ration would be much more expensive than either of the others quoted above.

Colt Feeding.—No general rules can be laid down for the feeding of colts; but, as in the case of the calf, it is very necessary that proper care should be exercised in the selection of foods. Cow's milk may be substituted, if necessary, for that of the mare. The colt should be taught to eat grains, any of which may be fed to advantage: the choice would depend on ruling prices. At times, when the colts are teething, it will be found more profitable to warm and moisten the grain ration. Hay of first quality, preferably alfalfa, should be fed in conjunction with the grain, so as to properly develop the digestive system.

SWINE FEEDING.

The same principles hold true in pig feeding as with other animals. Inasmuch as the largest demand is now for small pork, the aim of the feeder should be to produce as much growth as possible in a short time. The rations, therefore, should be rather nitrogenous, having a high percentage of protein when the pigs are young, or as soon as they begin to eat, and increasing the carbonaceous portion as they grow older. This principle is illustrated in the Table IV of feeding standards. We give two rations, one for alfalfa regions and the other for sections where alfalfa is not grown. Both rations are calculated for fifty pigs weighing about fifty pounds each, and can be changed in proportion as the pigs are lighter or heavier. The age of the pigs is supposed to be from two to three months:

Rations for 50 Pigs Averaging 50 Pounds Each.

Lbs.		Dry Matter.	Protein.	Carbohydrates.	Fat.	Nutritive Ratio.
30	Middlings	26.5	3.70	16.00	1.10	
50	Ground barley	45.0	4.80	31.70	1.00	
20	Alfalfa hay	17.8	2.46	7.42	.32	
200	Skim milk	18.1	6.60	10.60	.20	
	Total	107.4	17.56	65.72	2.62	1:4.1
10	Linseed meal	8.9	2.60	3.80	.70	
35	Corn meal	30.8	2.24	23.17	1.19	
55	Middlings	48.5	6.71	29.37	2.09	
200	Skim milk	18.1	6.60	10.60	.20	
	Total	106.3	18.15	66.94	4.18	1:4.2

The alfalfa hay may be fed in the long state, but the most economical way is to cut it in a cutting machine and mix with the grain and skim milk, allowing the mixture to soak twelve hours before feeding. If feeding green alfalfa, calculate 4.5 pounds of green for one pound of hay.

Alfalfa is one of the cheapest foods known for growing pigs, and so far as experiments show it furnishes the only pasturage upon which pigs may be kept without any other food. If expected to make much growth the pasture should be supplemented with some extra food.

POULTRY FEEDING.

The proper feeding of laying hens and other poultry should be conducted on the same lines as that of other farm animals. There are similar losses and wastes as are found in mammals, and there is the same necessity for replacing and replenishing the tissues, fluids, etc. of the body.

We must of necessity know the composition of the body of the fowl and of the egg, but after that we do not have to make new laws nor found new principles, but have merely to adapt the knowledge we have gained from the investigations made for other animals, to the hen; modifying rules and rations to suit the case in question. The scientific research called for, and urgently too, is that of ascertaining the digestibility of the different foods fed to the hen. For the cow, sheep, horse, and swine we have the digestive coefficient for almost every food consumed, while for the hen we have very few reliable data with which to work; and in view of the great value of the poultry industry it should receive more scientific attention than is at present allotted to it.

Many of the foods used for poultry are identical with those consumed by the cow, and the analysis of the remainder of the foodstuffs necessary for poultry, shows them to have the same ingredients as the others. Hence the principles expounded for the rational feeding of cows and other animals apply equally well to the nutrition of fowls. When feeding growing chickens the main object is to supply sufficient nourishment to insure hardy growth. In the case of the mature hen, it is a somewhat more complicated proposition. The feeder must bear in mind the fact that the eggs are also the product of the transformation or assimilation of the food eaten, and the nature of the ingredients of the nourishment requisite for their production is best seen by an examination of the composition of eggs, shown in Table VII.

TABLE VII.—ANALYSES OF CALIFORNIA EGGS.

1.—Proximate Analysis.

Shell, 10.81%; yolk, 32.47%; white, 56.42%.

2.—Composition.

	SHELL.		YOLK.		WHITE.	
	Parts per 100.	Referred to Entire Egg.	Parts per 100.	Referred to Entire Egg.	Parts per 100.	Referred to Entire Egg.
Water	....	....	49.70	16.13	36.48	48.79
Protein	....	....	15.54	5.05	12.07	6.81
Fat	....	....	33.43	10.85	.23	.13
Carbonate of Lime	93.75	10.14				
Carbonate of Magnesia	.95	.10				
Phosphates	.95	.10	1.04	.34	.55	.31
Alkalies, etc.	....	....				
Organic matter and water	4.35	.47				
Undetermined	....	....	.29	.10	.65	.38
Total	100.00	10.81	100.00	32.47	100.00	56.42

The yolk and white contain water, protein, fat, and a small percentage of mineral matter, while the shell consists almost entirely of mineral matter of which carbonate of lime constitutes 94% or over 10% of the entire weight of the egg. That is, in one dozen good sized eggs there are fully 2.5 ounces of carbonate of lime, familiar to all under the name of marble. We thus have proved to us the absolute necessity of a generous supply of lime in the diet of the hen.

In feeding other farm animals the quantities consumed per day are termed rations and the standards calculated for 1,000 pounds live weight; consequently, in order that the rations for fowls may be comparable with these standards, we will give the requirements for 1,000 pounds live weight, which for hens averaging three pounds is:

Dry matter.	Protein.	Fat.	Carbohydrates.	Nutritive Ratio.
52	8.4	4	33	1:5.0

Calculating this for 100 hens, we have respectively:

16	2.52	1.2	9.9	1:5.0

The analyses of the foods available for poultry feeding and compounding rations will be found in Tables I, II, and V.

From the data given there, the rations given below have been calculated.

Ration 1

6 lbs wheat
2 lbs bran
2 lbs middlings
5 lbs crushed barley
1 lb cocoanut oilcake meal
4 lbs alfalfa hay
.75 lb blood meal

Ration 2

11 lbs wheat
3 lbs bran
4 lbs middlings
2 lbs alfalfa hay
1 lb meat meal

Ration 3

1 lb wheat
3 lbs bran
5 lbs crushed barley
5.6 lbs cocoanut, oil-cake meal
5.5 lbs alfalfa hay

Ration 4

7.0 lbs wheat
3.5 lbs bran
2.0 lbs alfalfa
4.5 lbs crushed barley
1.0 lbs meat meal

Ration 5

9 lbs bran
5 lbs middlings
5 lbs bran
15 lbs skim milk

Mineral Matter.—While the above-mentioned rations are balanced with reference to the organic ingredients, they are not so when the mineral or inorganic constituents are considered; particularly is this true in the case of lime. If all the mineral matter in the foregoing rations were lime it would not be sufficient to meet the requirements for the eggs which the hens consuming the food would lay. We therefore see that lime must be supplied otherwise than by food.

Wastes of the Hen.—The mineral matter of the food eaten is not entirely assimilated by the body. And the composition of the hen manure, given below, proves that this is likewise true of the nutrients.

COMPOSITION OF HEN MANURE.

Water	56.00
Organic matter	25.50
Nitrogen	1.60
Phosphoric acid	1.75
Potash	.85
Lime	2.25
Magnesia	.75
Insoluble residue, etc.	11.30
Total	100.00

The unassimilated fat and carbohydrates are included in the "organic matter", and the undigested portion the "nitrogen."

The Lime Supply.—One of the best materials that a poultryman can use for supplying the requisite lime is oyster shell, or any other variety of shells. An experiment in this direction was made at the New York Experiment Station, and the result was such that the use of oyster shells during the laying season, where they can be cheaply obtained, was strongly recommended. It was found there that one pound of oyster shells contained sufficient lime for the shells of about seven dozen eggs.

Shells are not the only source for the lime necessary for egg shells. Bones also contain a large percentage of lime as is seen from the following analysis of clean dry bones of oxen and sheep:

	Per cent.
Carbonate of lime	6 to 7
Phosphate of lime	58 to 63
Phosphate of magnesia	1 to 2
Fluoride of calcium	2
Organic matter	25 to 30

Fresh green bones also contain, besides the lime compounds, some protein or flesh-formers, which add to its value as a poultry food. The best way to render the bones available is to have them broken by means of the bone cutter. One pound of the green bones is generally considered sufficient for sixteen hens. Besides the cut bones or oyster shells, the hens must have a generous supply of some kind of grit, very coarse sand or broken crockery. This grit serves as teeth for the hens, and when they are unable to obtain it indigestion and other ailments are sure to follow.

Necessity of Variety of Foods.—An examination of the rations given on page 46 proves that in order to have the proper proportions of the different ingredients, or to balance the ration, we must have a variety of foods at our command. It would be impossible to make a balanced ration solely from the grain feed-stuffs. If the necessary amount of flesh-formers is obtained by the use of grain, then the fat and heat producers in the ration will be greatly in excess; on the other hand, if the carbohydrates or fattening ingredients are made the standard, then when the proper proportion of this part of the food is supplied by the grain, the flesh-formers will be lacking to a considerable extent.

We have to depend on the peas, beans, different oilcake meals, blood meal or dried blood and fresh meat or meat meal for supplementing the deficiency of the flesh-formers.

By fresh meat is meant *lean* meat with the minimum amount of fat. Buyers should be careful in regard to this point, as a large percent of fat would be worse than useless for the purpose of the feeder.

All of these as noted in the tables are highly concentrated foods, the richest and most costly being dried blood or blood meal, containing about 80% protein, which is nearly twice the corresponding figure for meat meal and approaches four times the rating of this ingredient in the pea and bean. It probably varies less in composition than any of the foods in question. Experience has proved that the best results are obtained when some animal food forms a part of the ration in about the proportions shown in the foregoing rations.

The nutritive ratio of the ration, or the ratio between the flesh-formers and fat and heat producers, should vary according to the maturity of the hen and the period of feeding. The nutritive ratio in the case of growing chicks should be narrower than when the hen is mature or when she is being fattened for the market.

When the hens are not laying they only require a maintenance diet which is not as rich a one as that for hens during the laying period, either in flesh-formers or fat-formers and heat-producers; neither is there any necessity for the oyster shells or substitutes.

Foods for Growing Fowls.—The amount of food required for growing chicks and pullets is larger than that for full-grown fowls. According to Professor Wheeler of New York State Station the quantities of water-free food requisite for every one hundred pounds live weight fed, is 10.6 pounds at about one pound average weight; at two pounds live weight, 7.5 pounds; at three, 6.4 pounds; at four, 5.5 pounds; at five, 5.3 pounds; at six, 4.9 pounds; at seven, 4.7 pounds; at eight, 4.0 pounds; at nine, 3.3 pounds; at ten, average weight, 3.2 pounds of food. The amount of green or fresh food equivalent to the above different weights would be correspondingly increased. Professor Wheeler further states that these are the amounts taken by the growing fowls which normally attain to the higher weights given, and which are still immature and growing rapidly when at five and six pounds average weight.

Water.—The great necessity of water for the hen is shown by the high content of this element in the body and also in the egg. In one dozen eggs there is almost one pint of water. About four gallons of palatable water (one that is suitable for domestic purposes) are required per day for one hundred hens. Too much stress cannot be placed on the necessity of having good water, as impure water will undoubtedly cause sickness among the poultry. The more "green" food consumed the less will be the quantity of water needed.

FOOD VALUE OF FRUITS FOR LIVE STOCK.

The use of fruits as a part of the food for stock is exciting more attention on the part of the horticulturist every year. In almost every orchard there is some fruit which cannot be placed on the market. The chief causes for this are (1) the "windfalls," which are generally immature, and even if first-class, the fruit would be bruised or injured to such a degree as to preclude its sale. (2) Freights may be so high, and prices so low, as to leave no profit to the grower in any but the best of the crop; and sometimes even for that he receives very small returns.

The question, then, is what to do with the fruit? The idea naturally suggests itself to the orchardist to feed the fruit to cattle and hogs. But he is undecided as to its merits as a food for the animals and, as to the comparative value of the different fruits on the one hand and the grains and various feeding-stuffs on the other. The object of this article is to throw some light on the subject, and the following table, containing the analyses of some of the different California fruits, has been prepared in a similar manner to those of cattle-foods given above. Comparison between the grain and fruit may be made by referring to Tables I and II.

TABLE VIII.—COMPOSITION OF FRUITS.

A.—Edible Portion. Percentage Composition.

	Water.	Ash.	Protein	Fiber.	Sugar, Starch, etc.	Fat.
Apples	84.80	.50	.40	1.50	12.5	.30
Oranges	88.30	.41	.76		10.53	
Apple pomace	76.70	.50	1.40	3.90	16.20	1.30
Pears	83.90	.54	.56	2.73	11.46	.79
Plums	78.40	.52	1.00		20.18*a*	
Prunes (all)	80.20	.47	.85		18.48*a*	
Apricots	85.07	.48	1.04		13.41*a*	
Nectarines	82.90	.49	.63		15.99*a*	
Figs	79.11	.58	1.50		18.79*a*	
Grapes	80.12	.50	1.26		....	
Watermelons	90.25	.81	1.07		7.86*a*	
Watermelons (rind)	89.97	1.24	1.43	1.41	5.59	.36
Watermelons (pulp and juice)	92.07	.30	.76	.47	5.80	.60
Nutmeg melon (entire)	90.18	.66	.60	.48	7.85	.23
Raisins	18.95	2.24	4.50		67.71*a*	
Dried prunes	25.00	1.79	3.21		70.00*a*	
Dried apricots	25.00	2.42	5.23		67.35*a*	
Dried peaches	25.00	2.14	2.76		70.03*a*	
Dried figs	25.00	2.08	5.40		67.52*a*	

a Chiefly sugar.

TABLE VIII.—COMPOSITION OF FRUITS. (*Continued.*)
B.—Amount Digestible in 100 Pounds.

	Protein.	Carbo-hydrates.	Fat.	Nutritive Ratio.
Apples	.30	12.80	.2	1:44.2
Oranges	.57	9.66	....	10.9
Apple pomace	1.00	11.90	1.10	24.7
Pears	.42	12.90	.63	33.7
Plums	.75	18.40	....	24.4
Prunes (all)	.64	17.89	....	27.9
Apricots	.78	13.04	......	16.7
Nectarines	.49	15.77	....	32.2
Figs	1.12	17.95	....	16.0
Grapes	.95	17.72	....	18.6
Watermelons	.81	5.90	....	7.3
Watermelons (rind)	1.08	4.20	.28	4.5
Watermelons (rind, pulp, juice)	.57	4.58	.48	9.7
Nutmeg melon (entire)	.45	5.89	.18	14.0
Raisins	3.38	65.18		19.3
Dried prunes	2.42	67.80		16.7
Dried apricots	3.92	65.46		27.9
Dried peaches	2.14	68.07		32.2
Dried figs	4.03	64.62		16.0

NOTE.—In fresh stone fruit six per cent of the entire weight consists of pit. In dried fruit the corresponding percentage is about doubled.

Comparisons from the Tables.—Viewing these tables side by side, we note that the fresh fruits contain from eight to ten times as much water as do the grains and meals. Hence, equal weights of the two classes of foods could not be used with the expectation of obtaining from each the same nutritive value. This is true, even if the proportion of the nutrients were alike in fruits and grains; but the ratio is far from being similar, as is shown by glancing at the nutritive ratio of the different materials. Among the grains and meals the ratio is much narrower, and more nitrogenous, than in the case of fruits; that is, in the fruits there are more carbohydrates, for the same amount of protein, than is noted for the grains.

The next question is, how to compare the two kinds of foods? Suppose we try on the basis of the protein or nitrogenous part of the material; and for this comparison we will take wheat on the one hand and fresh apricots on the other. The former is a good average of the grains, and the latter of the fruits. The following little table shows the respective contents of the nutrients in 10 pounds wheat, and a like quantity of apricots, edible portion, which will be about 10.6 pounds whole fruit:

	Water.	Ash.	Digestible.			Fuel Value (Calories.)	Nutritive Ratio.
			Protein.	Carbo-hydrates.	Fat.		
10 lbs Wheat	1.14	.17	.91	6.42	.10	14,060	1: 7.3
10 lbs Apricots (fresh)	8.51	.05	.08	1.31	....	2,570	1;16.7

We perceive that wheat contains over eleven times as much nitrogenous, or flesh-forming, ingredients as we find in fresh apricots; in

other words, it would require 11 pounds of apricots to equal 1 pound of wheat. The same can be said of nearly all the other fresh fruits. Even in the case of figs, which yield, among the fresh fruits represented, the highest protein per cent., we would require 8 pounds to equal 1 pound of wheat in respect to this highly important element of the food. Hence we might say, in general, that the grains are from eight to twelve times as rich in muscle-forming material as are the fruits.

When we compare the foods as regards the carbohydrates (sugar, etc.), or heat-producers, the comparison is not so disadvantageous to the fruits. The wheat has only about five times the content of carbohydrates that is given for the apricots, as is shown by the figures 6.42 for wheat, and 1.31 for apricots; 5.3 pounds of apricots will have as much fattening ingredients as will 1 pound of wheat.

For some of the other fresh fruits, as figs, grapes, prunes, and plums, the proportion is still more favorable—from 3 to 4 pounds only of the fruit are equivalent in carbohydrates to 1 pound of grain, whereas in the melons the corresponding figures are from 10 to 12. Dried fruits make, naturally, a far better showing, as they more nearly approach in food value the grains, meals, etc. The following tabular statement illustrates this fact:

10 lbs. wheat contain .91 lbs. protein and 6.42 lbs. carbohydrates
10 lbs. raisins contain .34 lbs. protein and 6.52 lbs. carbohydrates

It is thus seen that the carbohydrates in the two materials are almost identical, and that the protein in the wheat is less than three times the amount found in raisins, which are a fair example of dried fruits. An inspection of the figures given for the fuel value, expressed in calories, will show the capacity of the different materials for producing heat and energy; the grains and meals rating from about four to twelve times higher than the fresh fruits, while the dried fruits do not differ materially in this relation from wheat and its by-products, and cocoanut-cake meal.

The fuel-value data alone, however, are not sufficient to determine the nature of the food; that is, whether nitrogenous or starchy. We must know the protein, or flesh-forming ingredients, in addition to the fuel value, in which case we can tell the kind of material in question.

How to Use Fruit in Feeding.—It would seem, from the foregoing, that the feeder is in a dilemma. If he wishes to give the necessary amount of protein to the animal by means of most of the fresh fruits in place of grain, he will have to add two or three times the requisite quantity of fattening or heat-producing ingredients—an addition not generally sought after. On the other hand, if the carbohydrates are made the standard, then when the proper amount of this part of the food is supplied by the fruit, the protein will be lacking to a considerable extent. It appears then, that, the best way out of the difficulty would be to use enough fruit to supply the fattening elements of the food, and make up the deficiency of flesh-forming material from some concentrated nitrogenous food, as cotton-seed meal or cocoanut meal. In this way the ration will be complete and more economical than if no fruit were used.

To illustrate: A cow (1,000 pounds weight) requires per day about 25 pounds of dry matter, containing 2.5 pounds of digestible protein,

12.5 pounds of carbohydrates, and .40 pounds of fat, with a fuel value of 30,000. If we have hays, grain, and bran, a good ration would be 12 pounds of alfalfa hay, 13 pounds of wheat hay, and 5 pounds of bran. The 5 pounds of bran could be replaced by 15 pounds of fresh prunes, and the deficiency in the protein resulting from the substitution could be made up with 1 pound of cotton-seed meal; or 5 pounds of raisins could take the place of the prunes, in which case ¾ pound of cotton-seed meal would suffice for the needed amount of protein. Either of the above changes from the conventional ration would make it complete with respect to its contents of digestible nutrients. But the objection might be raised, and with just cause, that the ration would prove very laxative. To obviate this, it would probably be best to use a less amount of fruit and mix it with bran or middlings, etc., to prevent "scouring" the animal. A little careful experimenting on the part of the feeder would soon settle the matter.

Equivalent Values of the Fruits, Grains, etc.—It would be almost impossible to compare the fruits and grains by means of their nutrients, because the ratios of the muscle-forming material to the fattening matter in the two kinds of foods are so different. But what can be done is to compute the valuation of each on the basis of 1.7 cents per pound for protein, 3.31 cents per pounds for fat, and 0.75 cents per pound for carbohydrate. These values are an average for those given in the Eastern and Middle States, and are, therefore, for this State only approximate, but sufficiently accurate for our purpose. Table IX is calculated from Tables V and VI, with the aid of these rates. A glance at this table gives us, perhaps, a better idea of the relative values of the foods under discussion, than could be obtained in any other way.

TABLE IX.—Showing Comparative Value of Fruits, and Hay, Grains, etc.

	100 Pounds Fruit Equivalent to Pounds of											
	Wheat straw.	Alfalfa hay.	Oat hay.	Corn.	Barley.	Oats.	Wheat.	Wheat bran.	Wheat middlings.	Rice bran.	Cotton-seed meal.	Cocoanut cakemeal.
Fresh Fruits.												
Apples	34	20	24	15	15	17	16	18	16	13	9	13
Oranges	33	19	23	14	14	16	15	17	15	12	8	12
Pears	40	23	30	17	18	20	19	20	19	15	11	15
Plums	50	30	36	22	24	25	24	26	24	20	14	20
Prunes	46	27	33	20	22	23	22	24	22	18	13	18
Apricots	40	23	29	17	18	20	19	20	19	15	11	15
Nectarines	43	26	30	19	20	22	21	23	21	17	12	17
Figs	50	30	37	23	24	26	25	27	25	20	14	20
Grapes	50	30	37	23	24	26	25	27	25	20	14	20
Watermelons	22	13	16	10	10	11	11	12	11	8	6	8
Nutmeg melons	19	11	13	8	9	9	9	10	9	7	5	7
Dried Fruits.												
Dried prunes	175	104	125	78	82	88	84	92	84	67	48	68
Dried apricots	194	115	138	86	90	97	93	102	93	74	53	76
Dried peaches	190	113	135	85	88	95	91	100	91	72	51	74
Dried figs	186	110	132	83	85	93	89	97	89	71	50	72
Raisins	216	128	153	97	100	108	103	111	103	82	59	84

It is seen that the least valuable of the fresh fruits mentioned in the tables are the melons, 100 pounds being equal to only 6 pounds of cottonseed meal, about 10 pounds of the grains, 5 pounds of hay, and 20 pounds of straw.

Apples and oranges are practically equal in food value, rating about fifty per cent. higher than the melons, as is seen by the figures for the equivalents of 100 pounds of these fruits, *viz.*, 24 pounds of hay, 16 pounds of grains, 13 pounds of rice bran and cocoanut meal, and 9 pounds of cotton-seed meal.

A good average of the pitted fresh fruits is represented by prunes, 100 pounds of which are equal in nutriment to 46 pounds of wheat straw, 27 pounds of alfalfa hay, 33 pounds of oat hay, 20 pounds of corn, 22 pounds of barley, 23 pounds of oats and wheat and its products, 18 pounds of rice bran and cocoanut meal, and 13 pounds of cotton-seed meal.

Hence, if wheat bran costs $15 per ton, fresh prunes would be worth as a substitute $3 per ton; likewise, if cottonseed meal is selling for $30 per ton, the prune value would be about $3.75. At the market price of oat hay, the figure for fresh prunes should be nearly $3 per ton.

The amount of nutrition found in grapes and fresh figs is identical, both rating about equal, as fodders, with the pitted fruits.

The dried fruits, as before stated, rank far above the fresh material as stock feed. This is amply proven by the table. Of the dried fruits represented in the table, raisins lead in food value; containing 1¼ to 1½ times the nutritive ingredients of alfalfa and oat hays, respectively; 100 pounds of the fruit being practically equal to the same quantity of grain, but to only 82 pounds and 59 pounds, respectively, of rice, bran, and cotton-seed meal.

Dried apricots rank slightly lower than raisins, owing to the latter containing less water. Apricots, however, are of equal value as a feeding-stuff with wheat bran; that is, the unsalable, dried apricots are worth to the orchardist about $15 per ton for feeding purposes.

It may be a difficult question at times to decide, when prices are extremely low, which would be the better economy: To feed the fruit to cattle, or to receive whatever small returns might be offered for it in the market. In such emergencies, a short soliloquy and a little arithmetic will decide the whole matter.

When there is no market for the fruit there is sometimes nothing left to be done but to feed it to stock. Under any circumstances, when stone fruit is used for fodder for hogs, it is be feared that when the animals crack large quantities of pits, poisoning may occur from the oil of bitter almonds and prussic acid present in the kernels. Precaution in this direction is unnecessary for stock, as they do not crack the pits. The stones or pits can be used to great advantage as fuel in the economical management of the farm.

Feeding Test.—A practical application of the foregoing was made by a feeder in the northern part of the State. He experimented, with a large sow, from which a litter of pigs had just been taken, by first feeding her a lot of dried figs and barley for about a week, to get her accustomed to the fig diet. She then weighed 260 pounds. For 9 days following she was fed all the dried fruit she would eat, consuming

220 pounds, or 24.4 pounds per day. Her weight had increased to 290 pounds, showing a gain of 30 pounds in nine days, or 3⅓ pounds per day.

It must be remembered that this sow was in an unusually favorable condition for a rapid increase in weight, having just been depleted by the litter of pigs; hence the above comparison is not fully demonstrative; and unfortunately we have no data for gain on full grain ration from the same place. But from investigations made at the Utah Agricultural College (Bulletin 40) the increase in weight per day of hogs weighing from 250 to 300 pounds, on a full grain ration, was about 1½ pounds. Hence we might conclude that pigs will increase in weight more rapidly from a ration of dried figs than from one of grains, etc. The gain in live weight per day from the amount of dried figs consumed (24.4 pounds) was 3⅓ pounds—that is, 1 pound gain required 7.3 pounds figs. This result agrees very closely with the figure 7.13, obtained at the Utah Station, for the number of pounds of grain necessary to produce 1 pound of gain in pigs of the same weight as the one in question.

It must be noted that, although 1 pound gain requires the same quantity, practically, of either the grain or figs, the pigs will consume about three times as much of the figs as they will of grain; therefore the gain will be correspondingly more rapid. Assuming the basis above discussed to be correct, this is a very important point if one wishes to place his hogs, of a given weight, in the market as soon as possible.

The thirty pounds gain was due to the 220 pounds of dried figs consumed. Hence at the selling price of the sow, 4½ cents per pound live weight, the amount realized for the figs was $1.35, which is equal to about $12.50 per ton, a somewhat low figure for the fruit. But the use of it as pig-feed saved the purchase of grain, and at the same time added 30 pounds to the weight of the animal in less than one-half the time that would have been necessary had grain been fed. The cost of the cereal ration, based on the ruling price of grain at the time of the experiment to produce the same gain, would have been about $2.00, which, at the selling price mentioned above, would have entailed a loss.

From the foregoing data it is seen that 200 pounds of a grain ration would be required to produce the same gain in weight as resulted from the experiment with figs. This corresponds quite well with Table IX.

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